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THE COMPENSATION OF WORKMEN.

By H. L. Gantt.

Interest in increasing the efficiency of production is probably wider and deeper today than ever before. More and more attention is being directed to methods that reduce preventable waste of material or effort, whether of machines or men—methods that employ all the factors of the manufacturing system to the maximum advantage. The most engrossing of all these studies concerns labor. It confronts a problem of relations between man and man that is as old as the world, but now jumps to far larger material significance because it is interlocked with the huge phenomena of the modern manufacturing system. Mr. Gantt's articles, beginning in this issue and continuing through probably four numbers, are based upon two lectures lately delivered at the Harvard School of Business Administration. They will present, with a fullness of demonstration never heretofore undertaken, his theory and practice of compensation and training of workmen so as to promote the profit and contentment of all concerned. These methods, he believes, would remove the present chief cause of antagonism between employer and employed. The first two articles will discuss the principles underlying the bonus system and the ideas embodied in it; those following will illustrate its application and results in practice, with the aid of some most interesting and remarkable charts.—THE EDITOR.

WE all like to feel that we are passing away from the age of violence, and approaching an age when justice and equity will have more influence in the world than brute force. If we rely too much upon the progress already made, however, we are bound to get into trouble. Kipling sounded a world note in his lines

> "An' what 'e thought 'e might require,
> 'E went and took, the same as me."

As far then, as acquiring property was concerned, he put the old Greek and the modern Briton in the same boat. The Japanese-Russian war was caused by the fact that each of two powerful nations wanted the property of a third weak one. Neither had any right to it, but the fact that each wanted it was enough to set aside all questions of right. Recently the seizure of the provinces of Bosnia and Herze-

govina by Austria was another example of an act done because the aggressor had the power to do it. The present alarm in Great Britain over Germany's armaments is not due to the fact that England thinks there is any real cause for a war, but the fear that if Germany has the power it will be used to the detriment of Britain. In other words, it is still accepted as common practice that "they should take who have the power and they should keep who can."

To come a little nearer home, we find that large corporations are not very much more squeamish or particular than large nations. The Standard Oil Company, the Beef Trust, the Sugar Trust, and any number of others, have absolutely no regard, apparently, for right or wrong. They get what they can by any means available. The difference between the savage and civilized communities is largely that the civilized communities have enacted laws which tend to restrain individual greed. Inasmuch, however, as it is impossible to foretell all the forms individual greed may take, it is impossible to enact in advance laws to cover all possible cases, and the best that can often be done is to make new laws to restrain new forms of greed as fast as they develop. Laws were made long ago that restrained robbers, sneak thieves, and even the "robber barons," but none have so far been framed that restrain the "high financier" who without giving anything in return, taxes the community for his own benefit to an extent that makes all other forms of acquiring without giving an equitable return seem utterly insignificant. One of the foremost American patent lawyers not long ago stated that the tremendous industrial success of the United States had been largely brought about by its beneficent patent laws; and yet the greatest part of the legal talent among the patent lawyers is engaged in evading those very patent laws, which are so beneficent to the community. These statements only go to show that in general it is only in so far as the laws restrain, that men fail to take advantage of each other. Certainly there are many honorable exceptions. There are many people who are actuated by higher motives, and who are doing a great deal to advance the cause of equity and justice, and to establish proper relations between human beings, and we give them all credit. But if we consider their methods the rule, and base our plans on them, we shall find that others, not quite so scrupulous, will get the better of us. Therefore in any discussion of the relations between employer and employed, we must recognize the fact that in the majority of cases men still act on the principle that "they should take who have the power and they should keep who can."

This is true whether you are speaking of employer, or employed. Labor unions are just as insistent in their demands for things that do not belong to them, as the Sugar Trust is in its efforts to evade duties that it ought to pay. One of the best illustrations of this spirit of which I ever heard, was incident to the ending of a strike in a western State, where the labor union had won. Soon after the men had gone back to work, one of the employers said to a workman, "I hope you are satisfied now." "No!" said he, "we are not satisfied, and we never shall be, until we come to the works in our carriages, and you walk!"

As long as the interests of the employer and employee seem antagonistic there will be conflict, and in any discussion of the subject, we must recognize that antagonism means conflict. Until we can find some means of doing away with the antagonism, the conflict will continue.

If the amount of wealth in the world were fixed, the struggle for the possession of that wealth would necessarily cause antagonism; but inasmuch as the amount of wealth is not fixed, but constantly increasing, the fact that one man has become wealthy does not necessarily mean that someone else has become poorer, but may mean quite the reverse, especially if the first is a producer of wealth. The production of wealth can be so greatly facilitated by the co-operation of employer and employed that it would seem that if the new wealth were distributed in a manner that had in it even the elements of equity, neither party could afford to have the working arrangement disturbed.

As long, however, as one party—no matter which—tries to get all it can of the new wealth, regardless of the rights of the other, conflicts will continue.

On account of the disregard of law and order that unions so frequently show in their strikes, it is the fashion in many places to condemn them as utterly bad, when they are only human. As a matter of fact they are not all bad by any means. They have done a great deal for the cause of workmen. If it had not been for them, the working people of today would probably be in the same condition as were those of England sixty or a hundred years ago. The average workman is a good citizen, just as loyal to his country as the capitalist, and just as proud of its position in the world. He is even more interested in its prosperity, for in times of depression when the capitalist loses his surplus the workman loses his means of living. It is a realization, perhaps, of the small margin that they have above their absolute needs, that makes workmen so liberal to each other,

for it is a well-known fact that the wage earner is far more liberal than the capitalist. He will go much further out of his way to help a friend than the rich man will, although it is much harder for him to do so.

Our method of studying labor problems in detail, and studying the individual workmen, has taught us much about them and given us a high opinion of them as men. The proportion of high-minded and honest men is just as great among them as among any other class, and far greater than among those people we continually hear complaining of them. Of course there are worthless and dishonest men among them, but the proportion is no greater than among those who have better opportunities. There are many individuals who do what they can to help their less fortunate friends, and there may be unions formed to help the poor workman; but as a business proposition, such a union cannot long be successful. Unions are formed as a rule by men of energy to help each other, and the poor workman is taken in, not for the good he does in the union, but the harm he does if not in. The poor workman is thus advanced with the good, and the employer pays the bill.

It is undeniable that unions have advanced the cause of workmen in general, and we must not blame them for using force to accomplish their ends. It was the only means they had. If we wish them to use any other means we must provide them with a means that they will consider more desirable, and that will give better results, for in this country, so long as a man conforms to the laws of the State, he has a right to govern his actions in such a manner as his interests seem to dictate. Men join the union because they think they will be better off in the long run for being in the union. The idea of the union is to get a higher rate of wages for the whole class, because in general nobody in that class can get a substantially higher rate unless the whole class gets a higher rate.

The employer usually pays but one rate of wages to one class of workmen, because, as a rule, he has no means of gauging the amount of work each man does. It is exceedingly difficult to keep an exact record of what each of a number of men does each day; and even if he had such records, the difficulty of comparing them would be very great, unless the work done by each man was of the same nature, and done under the same conditions. The result is that he keeps no individual records, but usually treats all workmen of a class as equals, and pays them the same wage. There may be 20 per cent who are very much more efficient than the rest, but he has no way of dis-

tinguishing them from the others with any degree of certainty; hence he declines to increase any wages, or makes the difference in wages insignificant as compared to the difference in efficiency.

In hiring men he offers the wages he can get the cheapest man for, and if the good man stood out for higher wages, he would not get any wages at all. Hence if the good man is to get high wages, the whole of his class must get high wages. This is the strongest argument for the formation of labor unions, and when they are successful in raising the class wage, as they have repeatedly been, the employer is forced to pay the poor man more than he is worth.

The desire of the union to take in all the members of its class is not philanthropic. Self-preservation is the first law of nature. Under ordinary conditions, a man will advance himself first, and his neighbor next. He will join the union to advance his own interests, and it is only right and natural that he should advance his own interests. Any community made up of people who did not advance their own interests would very soon go to pieces. If a workman thinks it is to his interest to join a union, he has a legal right to do so. If we wish to prevent him, we must make it to his interest not to do so. In other words we must provide him with means of advancing his interest that is superior to what the union offers. If any such scheme is to be permanently successful, it must be beneficial to the employer also.

Under ordinary conditions where there is no union, the class wage is practically gauged by the wages the poor workman will accept, and the good workman soon becomes discouraged and sets his pace by that of his less efficient neighbor, with the result that the general tone of the shop is lowered.

On the other hand, when the union has had the class wage raised, the inefficient workman is demoralized by getting more than he is worth, while the efficient man still does less than he could, for it is not absolute wages that stimulate exertion, but difference in wages.

Thus under both non-union and union conditions, where no individual records are kept, the employer fails to get the efficiency he should, and the general tone of the shop runs down. This is very marked in many old shops which have been successful in the past.

If shops are to be continually successful the efficiency of the workmen must not only not be allowed to decrease, but must be systematically increased. Increase of efficiency is essentially a problem of the manager, and the amount to which efficiency can be increased by proper management is in most cases so great as to be

almost incredible. Decrease in efficiency is not, as a rule, the fault of the workmen, but of the management, and the manager who continually complains of the decreasing efficiency of labor is simply advertising his own incompetence.

There are only two methods of paying for work; one is for the time the man spends on the work, and the other is for the amount of work he does. The first is day work. The second is piece work. All other systems, whatever may be their name, are combinations of these two elementary methods in different proportions. It is natural that the employer should wish to get all the work he can for the money he spends. It is also natural that the workman should wish to get all the money he can for the time he spends. Any other condition would be wrong, would be almost suicidal. These two conditions seem to be so antagonistic that most people give up any attempt to harmonize them, and adopts a scheme of bargaining. Bargains as a rule are made for a definite length of time, at the end of which they are revised. Under such a system the most aggressive group, or the one that has the most favorable conditions, wins in the long run.

Day Work.

Day work, or that in which men are paid for the time they spend, may be divided into two classes; first, ordinary day work in which there is no attempt made to keep individual records, and every man of a class receives the same wages regardless of the amount of work he does; second, that in which the work is carefully planned beforehand so that each man can have continuous work, and so that an exact record can be kept of what he does, and his rate of pay adjusted accordingly.

The day rate of any class of men, such as laborers, weavers, machinists, moulders, etc., is regulated by supply and demand, except where it is regulated by the union; and in times of extreme depression even the unions are unable to keep up the rate. The rate may be, and usually is, different in different localities. Under the condition where no individual records are kept, it does not make much difference whether one man is more efficient than another or not; it is almost impossible for him to get a higher rate of wages than the rest of them. If the pay of one is raised, others are apt to claim that they also are entitled to an increase, and in the absence of records it is impossible often to disprove their claim. To save discussion, then, and possible trouble, the employer declines to sanction any increase of pay. The industrious and efficient man naturally becomes dissatisfied and gradually slackens his pace to that of the poorer workman.

Thus the employer, who pays only the rate the poorer man can earn, gets only the efficiency he pays for, even from his capable man, who thus works far below his capacity.

This method of buying labor is similar to buying all materials sold under the same name at the same price, without regard to quality; but it is much more wasteful, as the difference in the quality of materials is seldom as great as the range of quality in workmen.

The result of this policy—and it is the logical result—is that the efficient man, the man with boundless energy to spare, says: "I can't get any more money by doing more work. I am going to see if I can get it some other way." Then he organizes all his fellows into a union, and they all say, "We want more money!" and they get it, and no man cares whether he does more work or not.

The moral tone of the shop and the community is lowered, as is always the case when there is a resort to force.

In the second class of day work some intelligent man studies the work to be done, lays it out carefully, perhaps several days ahead, provides the proper appliances, divides it up in such a manner that it can be done by individuals or by men in small gangs, so an exact record can be kept of what each individual or gang does, and compensation be made accordingly. Such a method of handling workmen has exactly the reverse effect, and their efficiency begins to increase at once. When we increase one man's wages because his record shows he deserves it, it not only does not cause trouble with the other workmen, but it acts as a stimulus to them, and we are glad to have each workman know what the others are making.

It is difficult and often impossible, especially at first, to plan all the work of a plant and to keep a record of each workman, but some planning can be done and some records kept in almost every case, and if a few steps in this direction are taken the advantage of taking more will soon become evident.

Some years ago it became necessary to lay off about ten moulders in a foundry working on day work with the record system. The superintendent sent for the records, and having inspected them, he sent the foreman a list of the men to be laid off. There was a great complaint, in which the foreman joined, that the wrong men had been selected, and that some of these men were the best in the shop. The superintendent invited an inspection of the records, which the foreman had never been willing to pay any attention to before, with the result that everybody was satisfied, and the efficiency of those remaining soon showed a very marked improvement.

MACHINE RECORD

Machine No._____

Month of _____ 190 Man's Name_____

	Day	Order No	Description of Work	Card Drawing No.	Inst. Card No.	Time Allowed	Time Taken	No. Pieces Finish'd				Remarks

If the conditions are such that we can plan out the work ahead of time, we will get a fair degree of efficiency by keeping individual records of the workmen, and raising their day rate accordingly. As a matter of fact, a better efficiency can be obtained by this method than by the ordinary system of piece work, where the rates are set by past records or the estimates of the foremen; and the tone of the shop is far better.

We began the use of individual records in a steel foundry in 1888, and have since always tried to plan our work so that records could be kept. With the introduction of our task and bonus system in the Bethlehem Steel Works, in 1901, the method of keeping these records became standardized. Figure 1 is a sample of the man-record sheet introduced in the works of the American Locomotive Co. in 1902.

Not long ago a large contractor in New York, who had been studying methods of handling his workmen efficiently, spent some time on one of his large excavating jobs. He provided a sufficient number of buckets, so that each man was always shoveling into a bucket by himself, and kept track of the buckets filled by each man. At once the number of buckets that came out of the hole was doubled.

No record can, as a rule, be kept of men doing miscellaneous work unless it is properly planned ahead of time with that object in view. If it is intelligently planned and an increased compensation given for increased efficiency, an improvement will result which will far more than pay for the expense of planning and record-keeping.

If, then, you train a man to be efficient and adopt a system of management which enables him to utilize all of his energies in productive work, you can afford to pay him far higher wages than he can get where the workmen are not trained and where the system of management is not such as will enable him to work continuously and efficiently.

A weaver in a cotton mill accustomed to having his warp ready and filling properly supplied, complains very bitterly if anything goes wrong. A man accustomed to having materials and appliances provided, objects strongly to being obliged to hunt up his own materials or appliances, even if he is required to get a correspondingly smaller amount of output. We have had many examples of workmen trained to work under an efficient system of management, who objected to working under an inefficient system.

One of the best examples of this occurred at the Bethlehem Steel Works, where men were unloading coal from cars at a rate of four

cents per ton. They heard that men were getting six cents a ton in Pittsburgh for this work and six of them left and went to Pittsburgh. At Bethlehem they were working two men on a car. At Pittsburgh six or seven men were put on a car, and these Bethlehem men were spread around, so that there were always strangers on the car with them. They started to work just as hard as at Bethlehem, but the other fellows didn't. The harder these trained men worked, the less the others did. The faster workers very soon slowed up, and in about two months the whole gang came back, and said they could not make as much money at Pittsburgh in the large gangs at higher wages as they did at Bethlehem at lower wages. It is a well-known fact that men in large gangs do not work as efficiently as men do individually, or in small gangs, but the man in charge of the work in Pittsburgh apparently did not know it.

To summarize: If you keep an exact record of what each worker does, surround the men with conditions under which they can work at high efficiency, and compensate the efficient one liberally, no man will spend his spare time trying to find out how to raise the wages of the other fellow. Workmen, as a rule, will do more work if their earnings are increased by so doing, and you will find great difficulty in getting the efficient ones into labor unions if they are not benefitted by joining.

The point that seems very clear is that the employer is quite as much responsible for the labor unions as the men are themselves, and that he can never expect to adjust his difficulties with the employees until he furnishes them with a means of accomplishing their ends (namely, bettering their condition and getting more money) which will appeal to them as being better than the means that they are now using; for as was said before, so long as he conforms to the laws of the State the workman has a right to govern his actions in the manner that will best subserve his own interests. As we cannot make him do anything else, we must convince him first that what we offer is better than what he already has. When he is convinced, the problem is solved.

FINANCIAL ASPECT OF THE APPLICATION OF ELECTRIC MOTIVE POWER TO RAILROADS.

By F. Darlington.

In our issue for September, 1909, we published a study of the traction problem by Mr. Darlington entitled "The Substitution of Electric Power for Steam on American Railways." His argument in that paper was addressed to the expediency of the adoption of electric power by steam lines as a defence against rising competition by trolley roads in the richest traffic territory. He pointed out that, at least during a period of transition, the electric and steam trains could be operated over the same rails, each for the traffic or service to which it might be best adapted. He urged that electric equipment be installed at points most vulnerable to trolley competition, with subsequent extension of the electrified lines as economy and profit dictate.

In the present paper he attacks more broadly the problem of relative economy in both local and long-distance traction, and pleads the cause of heavy, main-line through-traffic electrification from that point of view.—THE EDITORS.

EVER since the introduction of steam power cheapened the cost of hauling and thereby inaugurated a transportation business that had not been previously possible, especially for transportation on land, the location and extent of railroads have been determined by the laws of supply and demand and of cost and earnings. This relation of railroad costs and earnings has been changed in important particulars by the development of electric-railroad apparatus. Railroads create their own business, the amount of which depends upon the facilities they offer and the charges they make, and economies and improvements resulting from the use of electric power will lead to ever-increasing railroad traffic and will be a great factor in the future of this work.

THE FIELD FOR PROFITABLE RAILROAD OPERATIONS BROADENED BY ELECTRIC POWER.

By improvements, railroads have steadily reduced the cost of transportation, and their extent and scope have been correspondingly broadened. Prior to the application of electric power, however, the improvements were all the result of development following certain well defined economical lines and were limited by the nature of the steam machinery used. Although certain definite points in steam-railroad development have been marked by the introduction of distinctive changes, such as steel rails to replace iron rails, the air brake to

replace the hand brake, etc., the steam railroads of today are on the whole the result of gradual growth following improvements in the steam locomotive and its auxiliary appliances, and the extent of steam railroads is limited to the profitable use of steam apparatus.

The laws of profit and loss fixed by railroad earnings and operating costs with steam locomotives have resulted in steam railroads steadily going to larger and heavier trains without corresponding improvements in facilities for conducting local and short-haul business, the need for which is greater than ever.

Electric power has extended the field of profitable railroad operations in two ways:—

1.—By providing a cheaper means than steam for carrying on certain transportation work.

2.—By greatly increasing the earnings that can be secured in favorable locations, as has been done by electric trolley roads paralleling steam railroads.

Importance of Local Transportation the Collection and Distribution of Railroad Traffic.

The great bulk of transportation business has its origin or termination, or both, in short local hauls which steam railroads with their heavy trains are ill adapted to supply, so that local hauling is still done by wagons much the same as before railroads were built. At the same time, railroads have greatly increased the total of wagon hauling by increasing transportation business. If we consider the amount of local hauling compared with long through hauls, and compare the cost of wagon hauling with railroad hauls, the need for better facilities for handling local traffic will become apparent. Take as a single example the cost of transporting grain.

The freight on a carload of wheat from Chicago to New York City, a distance of 908 miles, is $3.90 per ton, which is about 0.43 of a cent per ton mile.

The cost per mile of wagon-hauling a ton of grain over country roads varies greatly with local conditions and the distance to be hauled, the nature of the roads, the cost of wages and of horse feed, etc. Without attempting too close an analysis, the cost of wagon hauling may be put at 20 cents to 40 cents per ton mile, and 25 cents per ton mile is probably a fair average under conditions prevailing in the United States.

Every five miles that a ton of material is wagon-hauled adds to its cost from $1.00 to $2.00 per ton, more or less; or in the case of grain,

say one-third enough to transport it from Chicago to New York City by rail. Practically every useful substance is transported over and over again by wagons or by other means than railroads, and the total cost of local hauling is a very large part of all transportation.

The enormous variety of traffic facilities offered by steam railroads, varying from long hauls of heavy merchandise to the transportation of light packages and mails and passengers, does not satisfy the demand for cheap hauling, but instead increases this need by augmenting traffic. It has been figured out that the cost of carrying merchandise by teams to and from a certain large railroad in the United States, is greater than the gross earnings of the road from its freight business.

Last year the annual income of the railroads of the United States was about $2,400,000,000 gross, or $28 per capita for 87,000,000 people. The annual gross railroad earnings in the United States are about two and one-half times the amount of the National debt, but yet there is an immense amount of money paid for transportation in addition to that which goes to the railroads, so anything that will improve local hauling is of great importance. Yet in face of all this, the tendency of modern steam-railroad development is to make railroads more and more carriers of heavy traffic and arteries for wholesale transportation, and to minimize or neglect the importance of local carrying, in spite of the fact that, per ton-mile, local hauling by wagons cost something like twenty-five times as much as railroad hauling.

Electrically Operated Railroads Better Suited Than Steam Operated Roads for Conducting Local Transportation.

Clearly, there is urgent need of a more effective and economical railroad means for collecting and distributing traffic, and this business is non-competitive and is the surest source of profit to railroads.

Any business that originates and terminates on points reached by competing railroads is competitive, since shippers have the option of using alternative routes. A vast amount of through business is competitive, since through business largely begins and ends at important terminals reached by more than one railroad. On the other hand, most local business originates or terminates with individuals, and individual local shippers in a majority of cases do not have equally available alternative routes between competing lines and must accept what is offered them without competition. Consequently local rates are not subject to variations resulting from competition.

A new aspect has been given to non-competitive business by the introduction of electricity as a motive power. Electrically operated

roads are particularly suited for this kind of work. This has been demonstrated by the great extension of inter-urban trolley roads, which have grown rapidly in mileage and importance and have done this in a number of States where the mileage of steam railroads has shown very little increase. They have been built in many places where local service is needed, especially for local business, either freight or passenger, requiring light and frequently operated trains; and thousands of miles of inter-urban electric roads are directly parallel to steam railroads, and for local business have proven better than steam roads because of better earning power and lower operating costs. They have definitely demonstrated, by actual operation, that there is a wide field for profitable electric-railroad business that cannot be advantageously done by steam-operated railroads. Steam railroads use every means possible to save a cent on long hauls, but in a majority of cases, have consistently neglected the great opportunity afforded by electric power to furnish profitably more and better local accommodations.

Conditions That Determine Where Electric Motive Power Is More Economical Than Steam.

In considering the application of electric power to steam railroads two things that must be kept constantly in view are:

1.—The increase of traffic and earnings that may be secured by the substitution of electric power for steam power, and of electric-railroad methods for steam-railroad methods.

2.—The relative cost of steam and electric power for conducting traffic.

These matters must be considered not only as affecting present railroad operations under present conditions, but broadly as applied to all work of transportation as now carried on by steam railroads, and as it may be increased by changed conditions resulting from the use of electric power.

Any scheme of extensive substitution of electric power for steam power on railroads involves such an enormous investment for electrical apparatus, such sweeping changes in the methods of operation and in the training of railroad employees, that—as steam engines are doing their work so efficiently—a very great superiority must be proven for electric power before it will be generally substituted for steam. To secure this superiority, advantage must be taken of the distinctive features of electric power, and its best use will not be made

by applying it to average conditions but to the conditions where electric power is especially suited to do the work.

Because electric roads possess advantages over steam roads for conducting local transportation, these roads do much local business which without them would have to be done by wagon hauling, and their accommodations build up local traffic. It has repeatedly happened that electric roads have paralleled steam roads and earned from local business two to four or more times as much as the amount of the local business of the steam road that they parallel. This is proof that a vast carrying business that is local between the patrons of steam railroads and main railroad lines can be better and more cheaply conducted by electric power than by steam. This applies to a great part of the present business of steam railroads and to a vast local traffic that could be profitably carried with electric cars, but that is now either non-existent for lack of accommodations or is being carried at enormous expense by wagons.

Electric Power for Main-Line Operation.

It is not intended to imply by the foregoing that through traffic cannot be advantageously handled with electric power, especially in view of the latest developments of electric appliances, many of which have not yet had time to be put into general use. Through trains can be operated with either kind of power, and in the present state of railroad progress, especially where it would not be profitable to operate trains at frequent intervals, the best economy will often be obtained by continuing main-line operation by steam; but in many places where fuel is expensive and boiler feed water scarce and poor of quality, or where frequent train service will bring better revenue than infrequent, either on main-line railroads or on branches or feeders to main lines, electric power has advantages for doing a vast profitable business, much of which it would not pay to do with steam and which if left to steam operated railroads would not be done at all.

In main-line operation there is too wide a variety of conditions to permit a specific statement defining the comparative economy of steam and electric power for moving heavy trains for through business. This work requires locomotives and not motor cars, and for such work the question is chiefly of the relative cost of locomotive service by steam and electric power. Steam engines are doing this work well. Will electric locomotives do it cheaper or better? Except in a comparatively few special cases, generally through tunnels, electric locomotives are not operating on main lines, but where they are doing so,

their work is economical and effective. For main-line operation there are two principal items of operating expense that are affected by the use of electric instead of steam motive power. These are fuel and locomotive repairs. There is a vast number of smaller items of railroad operating expenses that are affected to a greater or less extent by electric power; and there is one other consideration that is not an oprating cost and that in certain instances may be of great imporance, but in many other cases will not be a consideration at all; namely, the amount of traffic that can be handled over limited track space and in congested terminals by electric power is greater than can be handled by steam power.

Electric Operation Increases Capacity to Handle Traffic.

Referring briefly to this possibility of increasing track and terminal accommodations where electric power is substituted for steam; there are places where the advantages that can be thus secured will be worth millions of dollars. Steam-railroad terminals do not readily permit double-deck construction with tracks one over the other. On the other hand, where a large number of trains are to be electrically handled in a terminal, tracks may be superimposed one above the other; and furthermore, office buildings, warehouses, or other buildings may be erected over the tracks. With two decks of tracks instead of one deck, and with the extra facility for handling trains that can be had by electric power as compared with steam, the capacity of railroad terminals may be more than doubled, and in addition much valuable building space may be secured over the tracks. When large freight terminals come to be electrified in cities like Chicago, an excellent arrangement can be had by having one set of tracks on a low level for loading cars, and another set of tracks for unloading on a higher level; and over these tracks store houses and offices may be built, and connecting between all electrically operated elevators may be installed, capable, if desired, of handling entire cars.

Coal for Railroad Operation.

As already stated, coal is one of the principal items of railroad operation cost that is affected by the substitution of electric for steam power. This is such a tremendously variable item in different kinds of steam-railroad service and in different sections of country that even if a definite statement could be made of the effect on fuel consumption by electric operation, such a statement would be far from sufficient to determine the economy that would follow in any specific case. On different American railroads the cost of coal varies from about

$1.00 per ton, to $5.00, to $10.00 per ton, and the coal consumed by locomotives in different classes of service varies between wide limits. On an engine-mile basis the cost of coal ranges from 5 cents per engine mile, more or less, to as much as 50 cents or more. Mr. W. S. Murray, in a careful analysis of the consumption of coal by locomotives on the New York, New Haven and Hartford Railroad, published in the Transactions of the American Institute of Electrical Engineers under date of January 25, 1907, shows the saving in the cost of fuel by electric operations as follows:—

Express Service	51 Per Cent Saving
Express Local Service	54 " "
Express Freight Service	26 " "

The New Haven railroad makes its electric power with a steam-turbine power plant thirty miles from New York City, using coal to generate electricity, and Mr. Murray estimated that if the New York and New Haven Railroad lines were all electrified between New York and New Haven and New Rochelle and the Harlem River, the saving in coal alone would be $341,470 per year. Subsequent operation by electric power between New York City and Stamford has resulted in a saving in coal of just 50 per cent, exactly verifying Mr. Murray's earlier determinations.

Messrs. Stillwell and Putnam, in their very complete discussion of the broad question of substituting electric for steam locomotives published in the Transactions of the American Institute of Electrical Engineers under date of January 25, 1907, give the estimated saving in fuel by electric operations as 49½ per cent for average railroads in the United States.

There are many opportunities to use water-power electric plants for railroads and thus almost entirely dispense with the use of fuel. Some important main-line railroads in the United States, though they are in the vicinity of excellent water powers, are conducting heavy traffic with steam locomotives using high-priced coal that costs $.40 to $.50 or more per engine mile for freight service, and about two-thirds as much for passenger.

In Illinois, where coal costs railroads generally between $1.50 and $2.00 per ton (average about $1.55 per ton) the average cost of coal is about:—

For Freight Service	$.150 per engine mile.
" Passenger "	.086 " " "
" Switching "	.089 " " "
Average for all Service	.112 " " "

(Taking account of the number of engines in each class.)

The cost of fuel per train mile for railroads in Massachusetts in 1907 was, average:—

The Boston & Albany R. R.....	$.220	per train mile.
" Boston & Main "	.161	" " "
" N. Y. N. H. & H. "	.170	" " "
Average for all railroads in operation in Massachusetts.....	.170	" " "

To summarize the foregoing in a few words; the cost of fuel per engine mile varies in different localities, and for different classes of engines and different kinds of service, from $.05 to $.50 or more per engine mile. Where water powers are available the fuel could practically all be saved by building and operating water-power electric plants, and where there are no water powers and electric power for railroad operation must be generated by steam plants the saving in fuel would be about 50 per cent more or less.

Locomotive Maintenance and Repairs.

Maintenance and repairs of locomotives is another item of steam-railroad expense that is largely affected by electrification, and is so variable that averages are of little or no value for making comparisons of the cost of steam and electric locomotive repairs for any specific case. The average cost of locomotive maintenance for the United States is about $.09 to $.10 per locomotive mile. On a locomotive-mile basis the cost for freight locomotives is about 50 per cent greater than for passenger locomotives, and the range of cost of locomotive repairs is from about $.04 per mile for the lightest passenger locomotives operating under favorable conditions to over $.20 per mile for some heavy freight locomotives.

For railroads in Massachusetts the cost of locomotive repairs average for 1907 was:—

On the Boston & Albany R. R...	$.146	per locomotive mile.
" " Boston & Maine " ...	.052	" " "
" " N. Y. N. H. & H. " ...	.072	" " "
Average for all Massachusetts...	.070	" " "

These locomotives, however, were not all very heavy and many of them were in easy service. On heavy main-line railroads, especially where the quality of the boiler feed water is not good, there are important sections where the locomotive repairs average between $.15 and more than $.20 per locomotive mile for freight locomotives, and about two-thirds as much for passenger locomotives.

There is not a great body of data to determine the cost of electric-locomotive repairs, but such data as are available, backed by the best

judgment of many railroad men, point to a cost for heavy electric locomotives, equivalent in power to heavy steam locomotives, of about $.03 to $.08 per electric-locomotive mile under conditions where steam-locomotive repairs would probably be about two or three times this amount; so that for average conditions, about two to one in favor of electric locomotives is as fair an estimate of the ratio of locomotive repair cost (steam and electric) as can be determined at present. Clearly, since there are such wide variations in the cost of steam-locomotive fuel and repairs as $.05 to over $.50 per locomotive mile for fuel, and $.04 to over $.20 per locomotive mile for repairs, and since these are the costs most affected by electrification, it is essential to look most carefully at these items before passing judgment on any specific project.

Conditions Favorable for Main-Line Through-Traffic Electrification.

The electrification of main-line railroads will naturally commence at favorable locations:—

Where traffic is dense, that is, where the trains are frequent and heavy.

Where steam-locomotive coal is costly.

Where electric power is cheap, especially where cheap and reliable water power can be had. Let us consider briefly the case where steam-locomotive repairs are costly.

Approximate Analysis of an Existing Case, Given for Example.

An actual case examined shows about as follows; there are numerous places in the United States where similar conditions exist. An average of twenty heavy steam locomotives pass over a single-track road per day (including several locomotives in helper service on a high-grade section).

Coal costs $.20 per locomotive mile more or less.

Water powers can be acquired and developed for $75 per kilowatt more or less.

Steam locomotive repairs cost $.15 per locomotive mile, more or less, average.

On one hundred miles of such railroad, electric motive power compared with steam power would show a daily operating-expense balance about as follows:—(Excluding from consideration all items of operating cost such as wages of locomotive crews, etc., that may not be directly affected by electrification.)

OPERATING EXPENSES: REDUCTIONS AND ADDITIONS RESULTING FROM ELECTRIFICATION OF 100 MILES OF MAIN LINE WITH ELECTRICITY GENERATED BY WATER POWER.

	Daily Saving by Electrification.	Cost Added by Electrification Daily.
Cost of steam-locomotive fuel for twenty engines over 100 miles of track—2,000 engine-miles per day at $.20 per engine-mile. Per day.....	$400	
One-half of the cost of steam-locomotive repairs (one-half of $.15 per mile for 2,000 locomotive miles). Per day.....	150	
Other items of saving secured by electric motive power, including reductions in cost of maintenance of steel rails and ties, saving in water supply, roundhouse expenses, etc., at about $.02 to $.06 per locomotive-mile per day, or say $.03 more or less per locomotive-mile (for heavy main-line locomotives). (Note these items vary greatly on different railroads.) Per day.....	60	
Other savings secured by electric operation due to quicker movements and more reliable motive power than with steam; trains more easily handled and not having to stop for water and coal, all of which tends to reduce running time and lessen the working hours of train crews and many other expenses. This is difficult to value definitely, but should be worth on a busy main-line railroad, 100-mile section, from a possible saving of several hundred dollars per day maximum to at least $100 per day minimum. Per day.....	100	
Against these savings there would be charges for the operation and maintenance of a hydro-electric plant of say 15,000-kilowatts capacity—$15,000 to $30,000 per year for labor and maintenance, or say per day.....		$70
Maintenance of catenary trolley, of track bonds, of high-tension transmission lines, transformer stations, etc., per day, say.....		90
	$710	$160
	160	
Net reduction in expenses per day.....	$550	

These totals show in a general way about how some electrification schemes will work out, but all such general estimates are subject to wide variations in different specific cases. The figures are made on the assumption that the trains operated are the same train weights by electric as by steam power.

As a matter of fact, all other things being equal considerably heavier weight trains can be handled by electric power than with steam power, and even the single item of replacing the tenders of steam locomotives with useful cars would be quite important and does not show in the above figures.

To make the saving indicated would require an investment in a complete water-power plant and in transmission lines, trolley lines, transformer stations, and electric locomotives. Recent advances in electric railroading have made the installation of a plant suitable for the conditions above outlined much more practical and economical than would have been possible a few years ago. The cost of the entire installation would be in the neighborhood of $2,000,000, everything included, and this investment would be reduced by the release of a large amount of rolling stock consisting of steam locomotives and of coal cars used for carrying locomotive fuel, and of roundhouses, water stations, etc. The estimated saving at $550 per day after paying all electric-plant operation and maintenance expenses would be about $200,000 per year.

There are numerous places in which railroad conditions are quite as favorable for electric operation of heavy traffic as indicated by the figures just given, or more favorable; but few of these opportunities have received the consideration that they deserve.

There are two reasons for this.

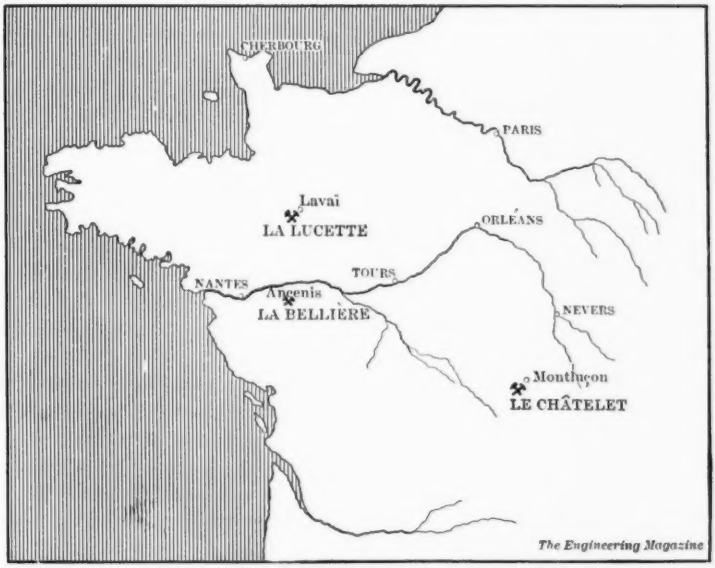
First:—Much time has been spent in making plans and estimates for changing from electric power to steam in places where the change would not be profitable generally because traffic is light and fuel and water conditions favor steam locomotives.

Second:—Very great improvements have recently been made in electric-railroad apparatus that render it possible to make far more economical applications of electric power to heavy railroad operation than would have been possible a few years ago.

Recent Improvements in Electric Railroad Apparatus.

A new system known as the single-phase alternating-current system is now in use on more than twenty railroads in the United States and on more than twenty-five roads in Europe. Electric locomotives of great power have been designed and built for operation on this system, using high-tension overhead-trolley circuits. Builders of this class of apparatus are now prepared to furnish locomotives of 2,000 or 3,000 continuous horse-power capacity and to equip railroads with overhead trolleys that are charged with current enough to supply two

or three or more of these mammoth locomotives at any point along the tracks as may be required. The trolley wires carrying the single-phase alternating-current are supported high over the heads of trainmen even when standing on the highest box cars. For several years this system has filled a useful place on inter-urban trolley roads, and on a few steam roads where it has been installed in preference to direct-current trolleys, but its greatest superiority will be found in heavy railroad traction over long distances, especially where large high-power locomotives are required. The older direct-current system is not used on long stretches of main-line railroad where heavy trains require large locomotive units at different points along a track, because for such work it is not economical to install or operate. The single-phase alternating-current system, on the contrary, unlike the direct-current system, is economical for heavy, long-distance main-line railroad work as well as for short distances, and single-phase alternating-current locomotives of great power are now being built. Street cars and inter-urban electric roads, and a few short sections on heavy railroads, are very well served by direct-current appliances; but the single-phase system has proven advantageous even on many such roads, and for regular steam-railroad conditions, where heavy trains are hauled long distances, the single-phase system is highly suitable in places where the direct-current system is not favorable. Especially within the last year or two since single-phase electric locomotives of great power have been designed, the opportunity in many places is excellent to secure good savings by heavy railroad electrification. It should be remembered that though electric railroads have been in process of development during the last fifteen or twenty years, their present extensive use is not by any means an indication of what twenty years' applications of today's electrical appliances would have done, or can do in the future for railroad work, since side by side with the commercial application of electric power to railroads there has been an advance in the capacity and efficiency of electric machinery for railroad uses.



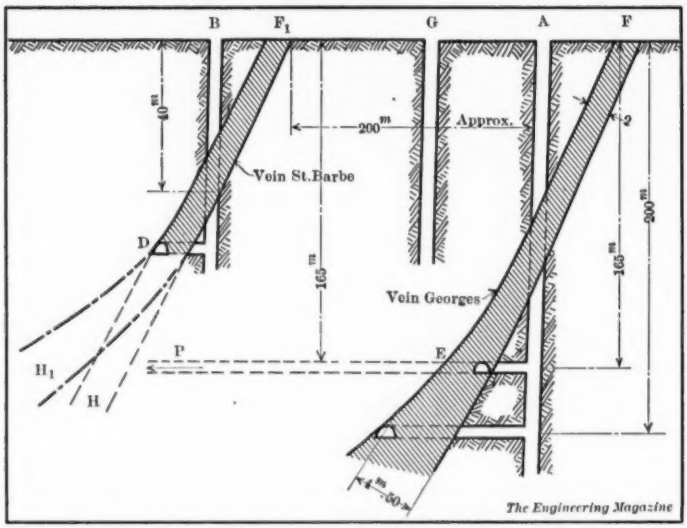
SKETCH MAP SHOWING LOCATION OF THE FRENCH GOLD MINES.

THE GOLD MINES OF FRANCE.

By Jacques Boyer.

MANY French rivers and streams rising in the Pyrenees, the Alps, or the Cevennes, carry minute scales of gold, but their wide dissemination in the bed of these water courses makes recovery practically impossible, since, according to the most accurate analysis, it would be necessary to handle about 7,000,000 kilogrammes of sand, in order to recover a single kilogramme of the precious metal. Gold-bearing veins are found at Gardette (Isère), in the tin mines of Montebras (Creuse), at Cieux and Vaulny (Haute-Vienne), in the copper deposits of Pontvieux (Puy-de-Dome), at Plancher-les-Mines (Haute-Savoie), in the silver-lead veins of Huelgoat (Finistère), and especially in the veins of La Lucette (Mayenne), of La Bellière (Maine-et-Loire), and Châtelet (Creuse). These last three occurrences, the only ones now worked in the country, (November, 1909,) form the subject of this review.

The mining concession of La Lucette, the first in point of time, extends over 841 hectares, situated near the town of Genest and 11.5 kilometres west of Laval (Mayenne), in a region characterized by the outcropping of a group of schists and quartzite belonging to the upper Silurian and the lower strata of the Devonian. The veins were first worked in 1899 for antimony, but when gold was discovered there in 1903 the development was undertaken on a larger scale by the Société Nouvelle des Mines de la Lucette, organized in April, 1904, with a capital of 3,150,000 francs, and today employing about 800 workmen.



SCHEMATIC SECTION OF THE VEIN SYSTEM AT LA LUCETTE.

The veins dip almost vertically and carry stibnite ($Sb_2 S_3$) in auriferous quartz. Gold occurs native in the form of minute scales or nuggets associated particularly with pyrite and mispickel. Up to the present time the company has scarcely developed even one vein, called the Georges vein, and has discovered another, the Sainte Barbe vein. Their general direction is nearly northeast and southwest. The Georges vein is of variable width, increasing in depth; thus, at the 100-metre level this width does not exceed 2.5 metres, while 100 metres lower down the vein attains a width of 5 metres. Furthermore, the length of the vein also increases with depth, one of the walls being vertical, while the other is inclined at an angle of 45 degrees. Thus, at the 50-metre level the surface length of 220

HEADWORKS AT THE MINES OF LA LUCETTE.
The Georges vein shaft house in the foreground, Ste. Barbe in the distance. Old antimony works at the extreme left.

metres has increased to 320, while at the 100-metre level it exceeds 450 metres. Each 15 metres of depth therefore gives an increased length of 30 metres. The richness of the auriferous quartz also appears to increase with depth, a somewhat peculiar condition, as usually in deposits of this kind the values decrease with depth, as the width of the vein increases.

The development of the Georges vein upon which the company has concentrated its efforts (although it has also built a hoisting plant ready to operate on the Sainte Barbe vein) is carried on through twin shafts, at present 220 metres deep. A cross cut has been made at the 200-metre level, but the vein is not being worked below the 165-metre level. As the accompanying sketch indicates, below the 165-metre level the Georges vein takes a flatter dip. As the length of the cross-cuts from the A shaft was thus greatly increased as the shaft descended, the engineers of the Lucette mine have begun to drive a central shaft G, which will cut the Georges vein above the levels now worked and will facilitate extraction.

For two years preliminary work has been carried on on the Sainte Barbe vein, which was met at a depth of 50 metres. At this B shaft a new headworks has been erected, containing among other things a special concentrating plant ready for operation, but held in reserve to increase the output of the company when expedient. For the purpose of reaching this second vein at greater depth, a cross-cut is being driven from the Georges vein at level 165, and this should reach the Sainte Barbe vein about 110 metres below the present workings. Specifically, according to the calculations made, the Georges vein worked from the 165-metre level down to a depth

PARTS OF THE SURFACE PLANT AT LA LUCETTE.
Above, the new antimony reduction works; below, the gold-milling plant.

of 265 metres, will assure the company of a minimum of ten-years output on the basis of an average extraction of 1 to 2 metres a month.

The first surface operation at La Lucette is hand picking of the ore as extracted and its separation into three classes:

(1) Auriferous quartz carrying from 20 to 25 grammes per metric ton. (2) Pure antimony minerals. (3) Mixed ore.

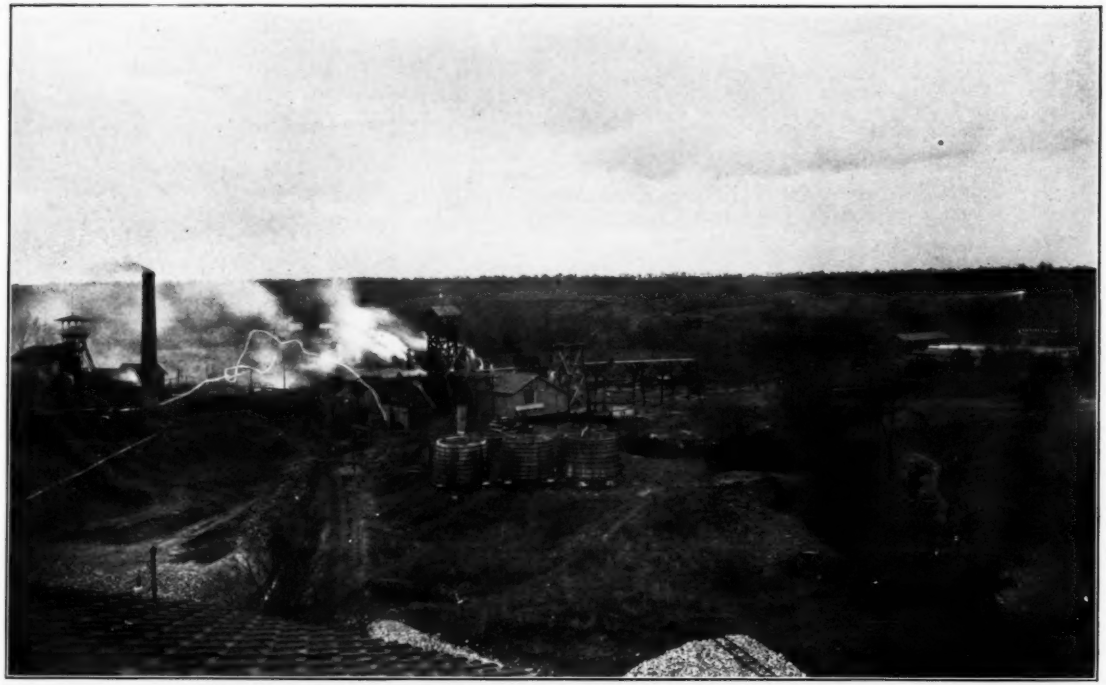
The gold-bearing quartz is sent to a crushing plant capable of handling 300 tons in twenty-four hours; thence after a single washing it goes to the stamp battery, while the antimony ores and the mixed ores go to a roasting furnace. The stamp mill comprises four batteries of five stamps each. The drop is 17 to 18 centimetres and each stamp falls from 90 to 96 times a minute. The installation of the last two batteries was not completed until November, 1908. The pulp flows over amalgamating plates, and the tailings from these pass over Wilfley tables which separate two classes of concentrates, carrying about 50 and 500 grammes of gold respectively. No cyaniding is done at La Lucette, the concentrates being shipped to Swansea, Wales, for extraction of the gold. It is not usual, indeed, to cyanide any except poor ores carrying only about 6 grammes to the metric ton, on which the cost of transport would be too high.

The treatment of antimony minerals was formerly effected in furnaces specially designed for sulphur; but during 1908 the company put into operation new works with a monthly capacity of more than 200 tons of antimony oxide and 150 tons of first-quality regulus. These oxidizing furnaces not only assure purity of product, but also enable the recovery of the larger proportion of the gold values. The old plant, however, has not been dismantled, and although idle since April, 1907, it could be placed in operation in case of need.

In the early days of the business antimony furnished the entire revenue of the mines of La Lucette, but the leading place is now taken by the gold output, and especially with the market decline of latter years antimony tends to become only a by-product. The average price of antimony in 1907 was 1,650 francs, and in 1908 but 825 francs per metric ton. The following table shows the approximate total production of gold and antimony at La Lucette for three years:

PRODUCTION FROM THE MINES OF LA LUCETTE.

Years.	Quantity of antimony extracted. Metric tons.	Value of antimony products. Francs.	Weight of gold produced. Kilos.	Value of gold produced. Francs.
1906.....	7,309	2,420,823	160	513,108
1907.....	10,266	2,620,061	320	1,050,379
1908.....	10,500	1,365,746	820	2,619,722



GENERAL VIEW OF THE OLD AND NEW SURFACE WORKS AT THE MINES OF LA LUCETTE.
Ste. Barbe shaft at the extreme left. Twin shaft houses on the Georges vein behind the smoke, in the left background. Old antimony works in the center, and new antimony plant in the right background.

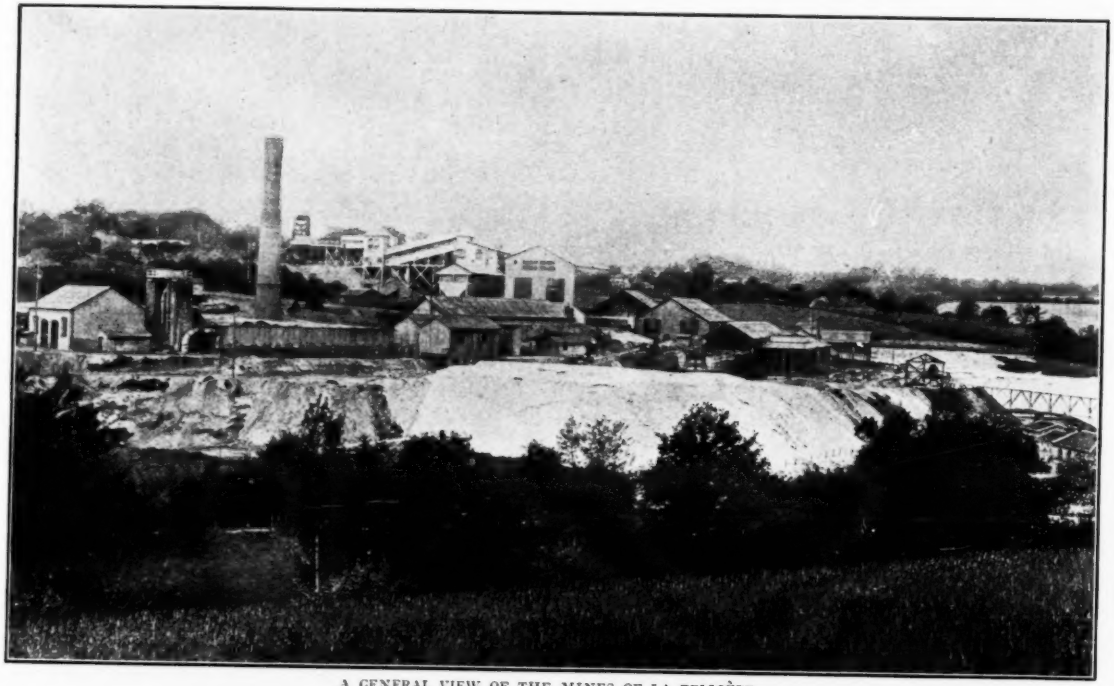
La Lucette alone furnishes almost one-third of the world's consumption of antimony and about one-half of the total production of France. Specifically, in 1907 (the last year for which complete statistics are available) the world produced 33,000 tons of antimony, of which France supplied 24,356, and La Lucette 10,266. The rapid development in mining the deposits of this company accelerated the fall in the price of the metal, and a substantial recovery in the market can scarcely be expected. Nevertheless, as remarked just above, in the present working of the mines of La Lucette continually increasing attention is being given to the recovery of gold. According to deductions drawn from an excellent study by M. Henry Laporte, the output in 1909 will probably reach 840 to 860 kilos, representing a gross revenue of about 2,800,000 francs.

The second of the French gold mines, chronologically speaking, is La Bellière, page 682, which has been actively worked for only four years. It is situated in the department of Maine-et-Loire, 15 kilometres from Ancenis. It employs 620 men, is very perfectly equipped, and its ore bodies are of rather high grade, carrying 16 to 17 grammes to the ton. The concession covers 508 hectares, and the mining company, with a capital of 4,000,000 francs, was organized in April, 1905. Since 1907 it has sold 1,500,000 francs of gold to the bank of France.

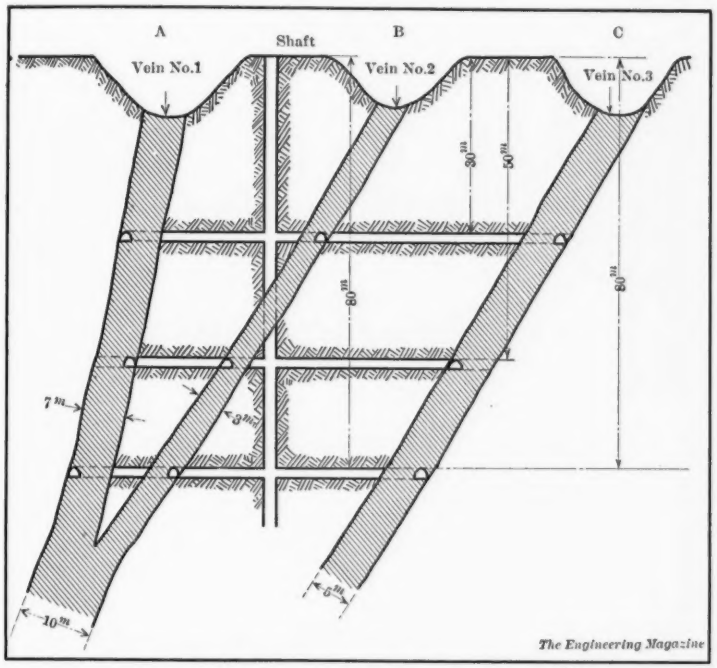
In walking across the estate of M. Blavier, a senator of France, one of his friends, an engineer of mines named M. Burthe, noticed a ditch partially hidden by bushes, which had not previously attracted attention. He believed it to be an indication of an ancient mine and forwarded samples of the rock to the Ecole des Mines of Paris. In these samples was found auriferous mispickel—that is to say, arsenical pyrite, carrying gold. Up to the present time the company has discovered three principal veins, of which the accompanying sketch indicates a theoretical section.

The first two, No. 1 and No. 2, seem in reality to belong to a single vein, for at a depth of 90 metres they run together.

The average width of the three veins is 7, 3 and 5 metres respectively; nevertheless, this width is quite variable, that of the principal (No. 1) vein reaching at certain places 8, 10, and even 12 metres. The veins of La Bellière have a dip of about 70 degrees. A particularly interesting feature of these deposits is that while they have been traced from east to west for a length of 500 metres, they appear to exetnd at each end well beyond this limit. This hope is supported by drilling operations, which several engineers from the



A GENERAL VIEW OF THE MINES OF LA BELLIÈRE.

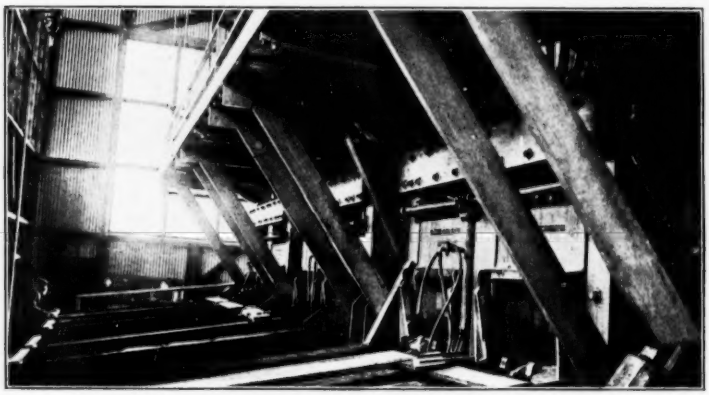


SCHEMATIC SECTION OF THE GOLD VEINS AT LA BELLIÈRE.

gold-fields have carried on to the west of the concession of the company.

The underground workings are carried on through four principal shafts, represented by one only in the diagram. Each shaft serves alike for all three veins, which are reached at three levels at depths of 30, 50, and 80 metres. The cross-cuts are driven to the vein, within which, and along either the foot wall or the hanging wall, the stopes are extended. Stoping is carried upward on a system of inverted steps, beginning at the level of the cross-cut. The ore is excavated upward to a height of about 2 metres parallel with the vein. As fast as it is broken down it is thrown backward, and a second gang shortly follows the first, a third coming after and so on. The workings occupy the full width of the vein. The run of ore as brought to the surface is not subjected to any picking, but after washing is sent to the crusher and thence to the mill by belt conveyor.

The mill at the present time contains seventy stamps, of which thirty were installed during the second half of the year 1908. These



AMALGAMATING TABLES IN THE STAMP BATTERY, LA BELLIÈRE.

weigh exactly 680 kilos. The forty older stamps are not so heavy, weighing but 476 kilos. The entire mill is now treating regularly an average of 260 tons a day. The company at first thought of installing tube mills, but abandoned the project on account of the hardness of its quartz ores, upon which the silica pebbles of the mill had an inadequate effect.

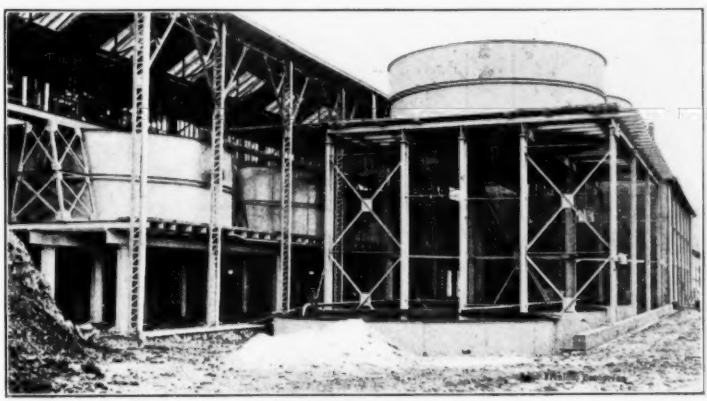
Passing from the stamp mill reduced to "30-mesh" the pulp goes to the amalgamating tables, which catch about 44 per cent of the gold. This proportion is much less than the recovery by amalgamation at La Lucette, where the mercury absorbs about 70 per cent of the precious metal. The small recovery at La Bellière is attributed to the presence of mispickel disseminated through the pulp. It has indeed always been recognized in gold milling that arsenic is a serious detriment to good amalgamation. After leaving the amalgamating tables the pulp is carried to shaking tables, where it is separated by gravity into concentrates, sands, and slimes. These three classifications, after the usual treatment, are cyanided to recover the last traces of gold. The operation is carried on in large circular tanks mechanically charged and discharged, and the cyanide solution then goes to the gold boxes, where the gold is deposited on zinc. This last operation is carried on in carefully enclosed and strictly guarded rooms.

As already noted, about 44 per cent of the gold is caught by amalgamation and the cyanide recovers further about 45 per cent. In total, therefore, the recovery at La Bellière is close to 89 per cent,

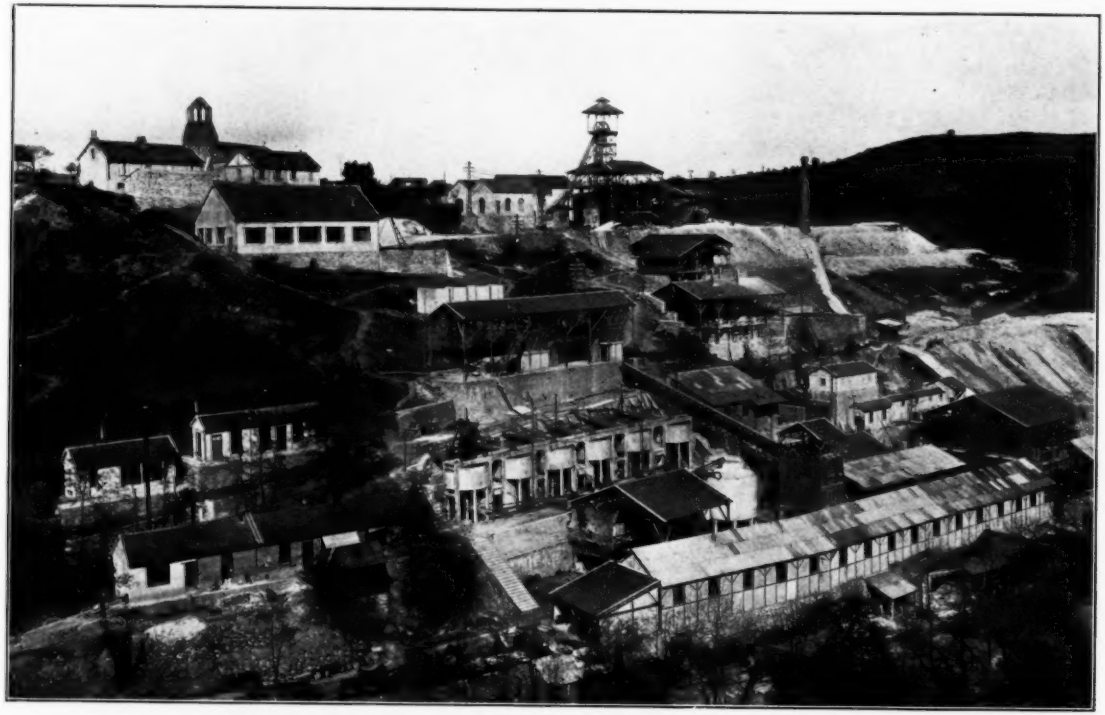
which is a very good figure. According to the statements made by the president at the general meeting, June 18, 1909, production hereafter may reach 450,000 francs of gold a month, which represents very nearly 130 kilos of the precious metal, or about 1.6 tons a year altogether.

Besides its gold output from La Bellière, the company has a source of revenue which so far has played but small part, but which may at some day be very interestingly enlarged. This is arsenious acid. After giving up the residue of their gold contents to cyanidation, the sands and the concentrates, which contain a notable proportion of sulphide of arsenic, are sent to roasting furnaces. The heat derived from the oxidation of the sulphur distills the arsenious acid over into large cooling chambers, where it is collected. After that it is necessary only to refine it in a second group of furnaces from which it comes in a remarkable state of purity—about 99.6 per cent.

The installation of arsenic furnaces at La Bellière is quite recent, and this explains the fact that in 1908 the company produced only 10 tons of arsenious acid, representing a value of 3,370 francs. Very different results will appear in future, because with its new equipment the plant is capable of producing 2 tons a day or about 660 tons a year. As the present price of pure arsenious acid is about 340 francs per ton, it is evident that the company may thus put into its treasury 200,000 francs annually, representing a net gain of at least 120,000 to 150,000 francs. It is worth adding, further, that as



CYANIDE TANKS, LA BELLIÈRE.



GENERAL VIEW OF THE MINES OF LE CHÂTELET, TAKEN FROM ACROSS THE TARDES.

the world's consumption of arsenious acid is not very large, La Bellière will, without doubt, exercise a preponderating influence in this market in the future.

The Châtelet mines have scarcely commenced the stage of regular working, although the deposit was noticed long since in a strictly scientific way by M. Delaunay. It was not thoroughly explored until 1904, and a long series of investigations was necessary before the concession was obtained. The order was signed July 29, 1907, and grants an area of 781 hectares to the Société des Mines d'Or du Châtelet, with a capital of 8,000,000 francs. An application for the extension of the concession covering 3,877 hectares was filed in June, 1909.

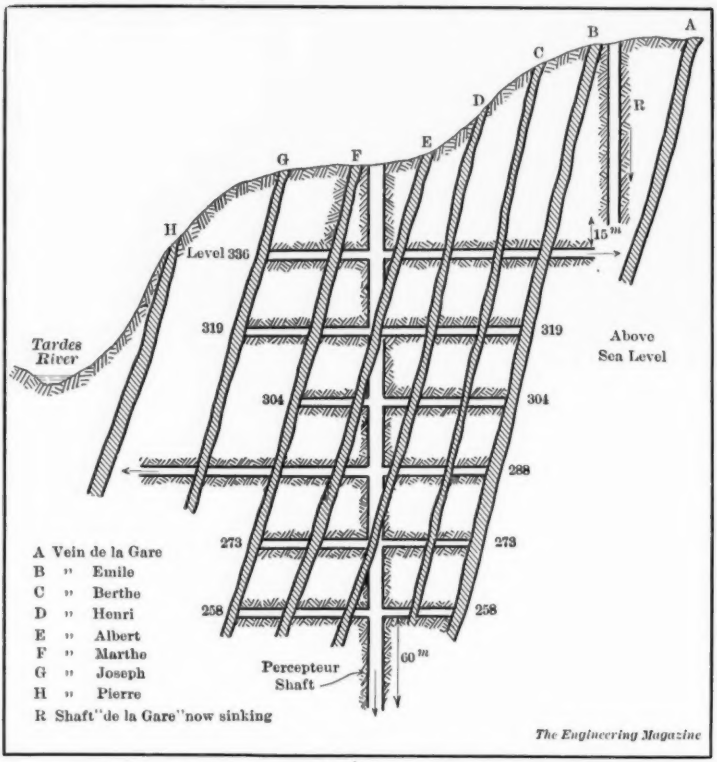
The mine is situated in the department of La Creuse, 20 kilometres southwest of Montluçon, near the hot springs of Evian. The ores carry gold only, and the formation is distinctly fissure veins. The ore is a scarcely transparent quartz, poorly crystallized, tinted with rose color or blue, often decomposed, and pierced with cavities. Gold is disseminated in it in small particles, often invisible to the naked eye. A few samples of extraordinary richness have been taken out, but the average stated by the promoters themselves is 28 to 30 grammes to the metric ton; La Lucette ores show only 20 to 25 grammes, La Bellière 17, and the Transvaal only 12.

Investigations begun four years ago, and carried on actively to the present moment over the entire region, have proved the existence of eight veins, which sometimes approach and sometimes recede from one another, giving zones of varying richness. As indicated on the theoretical diagram, page 688, these eight veins are approximately parallel.

They have been recognized for a length of between 250 and 300 metres on the various levels, but very probably they extend well beyond those limits. It is likely that their network extends for several kilometres and that they cross the surface of the concessions from one end to the other.

The irregularity in thickness of the veins above alluded to is certainly disturbing. What there may be beyond a depth of 100 metres is unknown, and if it is permissible to hope that the ore increases in width and in richness with depth, it is also possible that the veins pinch out so as to present no further interest from a mining point of view. It should be stated, however, that according to the opinion of several specialists, the cleanness of the vein walls is a strong argument in favor of the extension of the seams to depth and of a gradual increase of their width.

The mine at Châtelet is worked through a single shaft called the "Percepteur" shaft. Only five veins have been opened, the workings being carried on at the levels known as 336, 319, 304, 288, 273, and 258, these being the elevations above sea-level. The shaft has been sunk about 60 metres below level 258, but is not yet equipped for working at that depth.



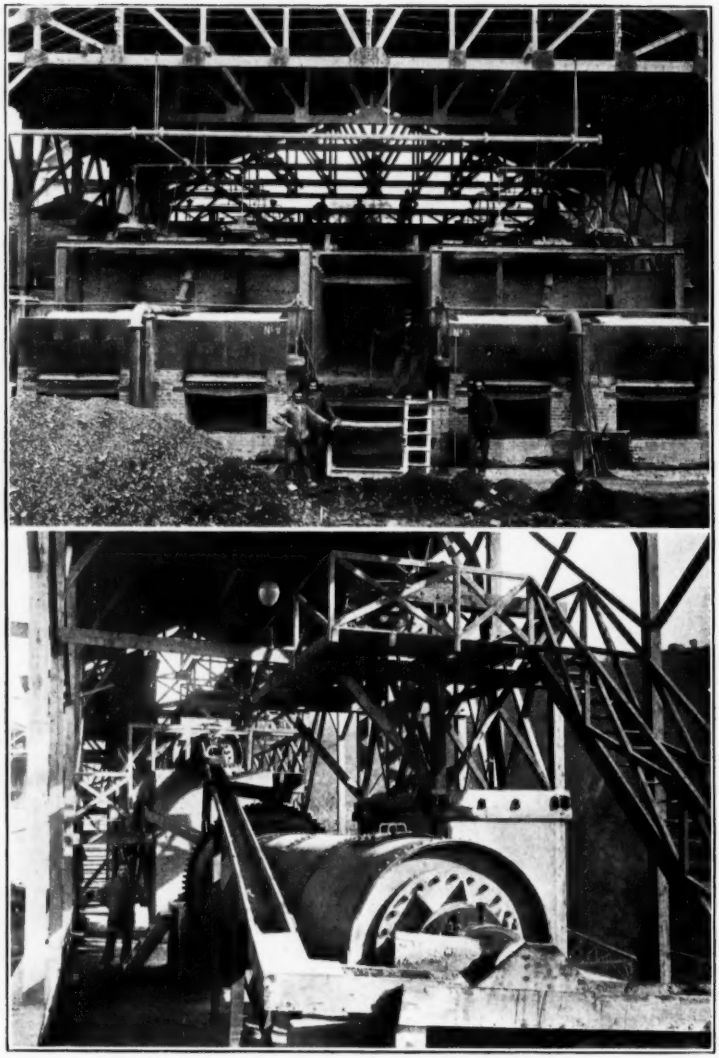
SCHEMATIC SECTION OF THE CHÂTELET GOLD-BEARING FORMATION.

Two main cross-cuts have been driven from the shaft, the first being intended to reach the "Pierre" vein at level 258 to the eastward, and the other being driven to the westward to strike the vein de la Gare at level 336. In this vicinity, also, the company has begun the sinking of a second shaft, which, at the time of writing, (November, 1909,) is but 15 metres above the level 336 and probably will soon reach the network of veins. The great complexity of the ore

HIGH-TENSION SWITCH BOARDS, LE CHÂTELET MINES.
The current comes from hydro-electric works on the River Cher.

to be treated at first baffled the engineers of the company, but after trying many different methods they adopted the following order of processes:

The ore as it is raised is hand-picked in the upper part of the headworks. Thence it goes to the breaker, to the ball crusher, and the drying furnace. This last operation is necessary for the evaporation of water, which otherwise would interfere with the following operation of roasting. The roasting is effected in two groups of Merton duplex furnaces, page 690, the design coming from Australia. The double sulphides are thus broken up and the sulphur and a large part of the arsenic are driven off. The roasted product is then sent directly to tube mills, where, as the miners say, it is "ground to death." Stamp mills would be ineffective on a material so complex and in which the gold is in particles so minute. Amalgamation also is inapplicable. It was tried at first, but recovered scarcely 3 per cent of the gold. Recourse is therefore had, as in many Australian mines, to simple cyaniding. The cyanide solution is introduced into the tube mills, where the process is favored by the agitation of the liquid by the pebbles. It is pursued further in six large circular tanks, where the maceration is continued uninterruptedly for seven or eight hours. The cyanide solution from these tanks is passed through two batteries of Ridgway filters (a



CONCENTRATION AND MILLING PROCESSES AT LE CHÂTELET.
Above, the duplex Merton furnaces for roasting the ore; below, the tube mills.

third is now being constructed) in which filtration is accomplished with the aid of both pressure and of partial vacuum. The only remaining step is precipitation of the gold from the cyanide liquor by zinc shavings.

In the general arrangement of the plant a very judicious use has been made of the irregular level of the ground so as to secure economical movement of the ore from the head of the shaft through the various furnaces to the precipitating boxes, which are installed at the bottom of the valley on the very brink of the Tardes. According to M. Henry Laport cyaniding recovers about 87 per cent of the gold in the ore as it enters the tube mill.

At present the daily output of the tube mills at Le Châtelet is about 125 to 150 tons, from which nearly 2 kilos of gold is extracted. The financial workings of the enterprise are as yet unknown, and must be proved in the future, as it has been operating regularly only since March, 1909.

To close this short study, the characteristics features of the three enterprises just described are condensed and tabulated below:

Name of Mine	Ore Bodies	Nature of the Ore
La Lucette	Two veins discovered. Only one worked.	Stibnite enclosed in auriferous quartz.
La Bellière	Three veins of which two unite at depth.	Quartz with pockets of auriferous mispickel.
Le Châtelet	Eight veins discovered. Five worked.	Quartz impregnated with auriferous mispickel.

Name of Mine	Average Contents of the Ore	Method of Treatment	Monthly Production of Gold
La Lucette	20 to 25 grammes to the metric ton.	Stamp milling and amalgamation.	About 70 kilos
La Bellière	16 to 17 grammes to the metric ton.	Stamp milling, amalgamation and cyaniding.	About 130 kilos
Le Châtelet	28 to 30 grammes to the metric ton.	Roasting, tube-mill grinding and cyaniding.	About 65 kilos

In conclusion, although the production of gold in France may not yet be very important, yet this country seems destined to play a certain rôle in the world market for the precious metal. Furthermore, the search of the prospector has scarcely more than begun on this old Gallic soil, whose riches of gold were envied by Rome, and whose future may possibly be that of a new Transvaal.

THE DESIGN, CONSTRUCTION AND OPERATION OF CENTRIFUGAL PUMPS.

II. SOLUTIONS OF THE PROBLEM OF BALANCING AXIAL THRUST.

By Franz zur Nedden.

Mr. zur Nedden's critical discussion of the turbo-pump began in our January issue, the first part being devoted to mechanical and hydraulic losses. The present installment takes up some important problems of design and construction. Following numbers will be devoted to structural features and manufacturing considerations and to the turbo-pump diagram and its practical interpretation in service.—THE EDITORS.

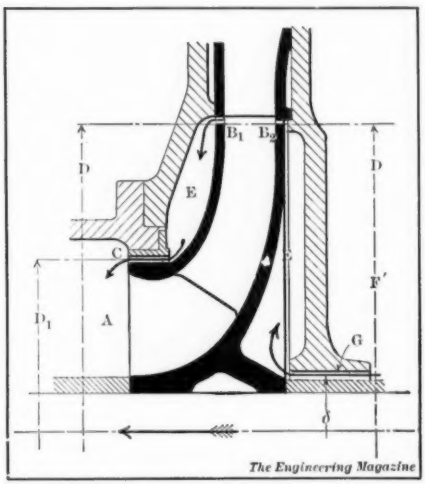


FIG. 8. LOCATION OF LEAKAGE LOSSES.

BALANCING axial thrust is the most important problem of high-lift turbo-pump design. The various systems in use are characterized in the first place by the methods of control adopted. It is therefore impossible to treat the subject without at the same time considering in some detail the fundamental forms of existing types.

Axial thrust is not caused solely by static-pressure differences. Of course, the normal one-sided impeller wheel shown in Figure 8 will tend to push the shaft in the direction indicated by the arrow. Looking superficially at the pressure conditions, we see that there is a thrust in the direction of the arrow (Figure 8) equal to

$$(D^2 - {}^2)\ \frac{\pi}{4} \times pc$$

pc being the pressure at the circumferential clearance CD (Fig. 2,

page 548, The Engineering Magazine, January, 1910), and an opposing pressure expressed by

$$(D_1^2 - \delta^2)\frac{\pi}{4} \times p_A$$

p_A being the initial pressure of the stage. The resultant is a thrust in the direction of the arrow equal to

$$(D_1^2 - \delta^2)\frac{\pi}{4} \times (p_C - p_A) = P$$

In addition, the pressure in the right-hand chamber (E, Figure 8) rises by the continual influx of water from the next higher stage (that is, as we saw in the preceding article, from F^1), whereas the pressure of the left-hand chamber E must decrease by the continual efflux into chamber A. On account of these processes the axial thrust baffles exact calculation, and it is not constant even with one and the same pump, but increases with the degree of leakage through G and C, Figure 8—that is, with wear and tear.

A number of dynamic influences which supervene, and are often quite exceptional, completely destroy any possibility of exact calculation. For instance, if, on account of the use of crooked core boxes or through other circumstances, a majority of the cores are inclined in one direction, the wheel will show an elevation of the form exaggerated in Figure 10. The reaction of the force exerted upon the water by each impeller blade is no longer rectangular to the axis of the shaft, but acts in the direction M N perpendicular to the blade surface. This force M N is resolved into the component M O, rectangular to the main axis, and a small axial component M P. The sum of all these axial components M P forms an additional axial thrust which sometimes is quite important.

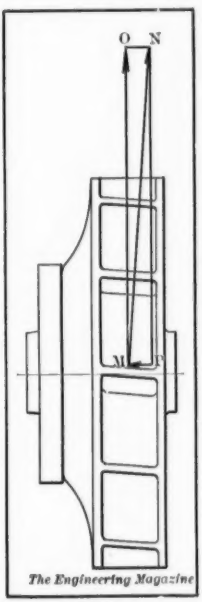


FIG. 10.

Another very interesting example is afforded by the experience which a well-known manufacturing concern gathered through the application of reinforcing ribs (R, Figure 11) in the chamber to the left of the wheel. Allusion was made in the preceding article to the formation of gyroscopic pressure by rotation of water in these chambers corresponding to the rotation of the

wheel. With the construction mentioned just above, this gyroscopic pressure was free to develop in the right-hand chamber, as nothing hinders the rotation of the water; in the left-hand chamber, on the contrary, the ribs interposed such obstacles that a great part of this pressure was destroyed by wild vortices. Therefore, although the axial thrust should have been balanced if only static pressures were reckoned with, it appeared in quite a dangerous amount when the pump was operated. Upon covering the ribs with a conical iron plate, as indicated by the dotted line in Figure 11, the phenomenon disappeared.

Danger may arise, also, if the edges K K do not coincide with absolute exactness, and it is impossible to erect the inner parts accurately enough to insure perfect agreement. The constructor can obviate the difficulty by making the internal measurement of the impeller at L about one-sixteenth of an inch smaller than the entrance to the guide wheel. Nevertheless, it sometimes occurs that the water is hurled against the edge K' Figure 12. The vortex of the swirl, as shown, absorbs a good deal of the pressure through the clearance K', and consequently there is not much tendency for the water to flow in the direction of the arrow I. On the other hand, the reaction of the guide apparatus against the entering water particles tends to push them out of the opposite and corresponding opening, as shown by the arrow II. Pressure therefore rises in the right-hand chamber and falls in the left, and again the result is an additional axial thrust.

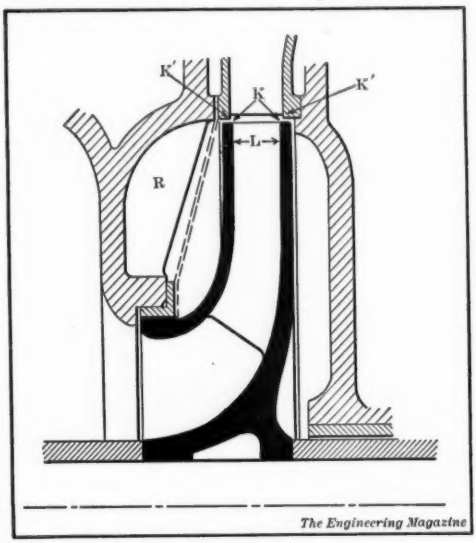


FIG. 11. AXIAL THRUST CAUSED BY IMPEDED ROTATION OF WATER IN R.

I had the opportunity, while working with some high-lift centrifugal pumps, which admit of extremely fine balancing, to observe that the axial thrust changed from the direction of the suction to the direction of the discharge, depending on the volume of the delivery. This phenomenon is probably due to a one-sided clinging of the

water when it is passing through the pump in reduced quantities which, so to speak, do not require the full area of the passages. The exaggerated diagram, Figure 13, will serve to show that here again one chamber will be filled under higher pressure than the other.

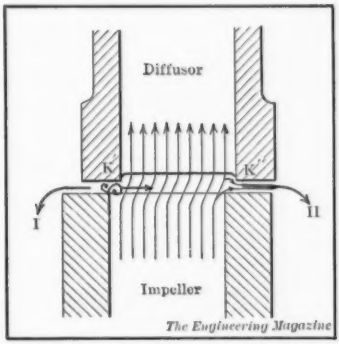


FIG. 12. DISPLACEMENT CAUSING THRUST.

It will now by clear from even this short consideration of the causes of axial thrust, that the most perfect balancing possible does not avoid the necessity of an auxiliary balancing device, such as a thrust bearing or something similar. The determination whether the axial thrust of each wheel shall be provided for separately, or whether whole groups of wheels shall be balanced by a special structural arrangement, is fundamental and has far-reaching consequences upon type. Each of the methods is adopted by prominent firms, and on looking over the field we find the same means employed in both cases.

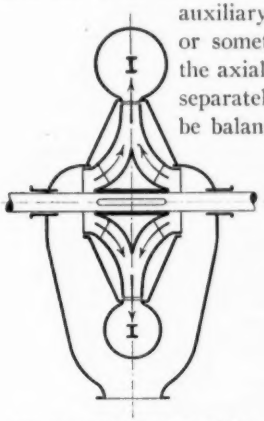


FIG. 14. DOUBLE-SIDED PUMP.

The most obvious method of taking up the thrust is the so-called old Sulzer method. The impeller of the plain centrifugal pump without guide wheels with which Sulzer began was double-sided, as shown in Figure 14, and was thus balanced by its own symmetry. Slight fixture of the axial position, as, for example, by a simple step collar, was sufficient to prevent the so-called "snapping over" of the rotor; for, if the axes of impeller and diffusor ever get out of line, as shown in Figure 12, the effort of the water is always to force the wheel further out of truth — the wheel snaps over. Sulzer's first high-lift pumps always show the combination of two one-sided

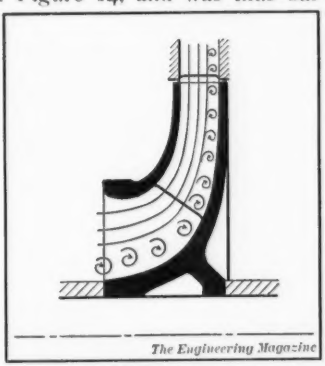


FIG. 13. LOW-DELIVERY VORTICES.

wheels, as in Figure 15. We might say that the original double-sided wheel had been cut in two on the plane 1 1, Figure 14. The manner in which the two combination wheels were coupled one behind the other was, however, rather complicated. The guide channels of the second stage used only half of the whole available area of the guide-wheel ring, the channels of the first stage being intertwined between them, as shown in Figure 16. This construction was very inconvenient from a manufacturing point of view, but nevertheless it offered, perhaps unintentionally, some great advantages; for the designer was, of course, forced to compound the space available for the guide channels, and they thus became long and narrow—that is, excellently fitted for transforming speed energy into pressure. The principle of balancing axial thrust by counterposition is available also in another form which is applied to the method of group balancing by Messrs. Weise & Monski, Halle a-S., and illustrated in Figure 17. The water drawn in at A passes impeller 1, guide wheel 2, impeller 3, and guide wheel 4. Thence it flows into a large by-pass channel, 5 5, and thence to the third impeller, 6, from the opposite side. Rotor 6 thus opposes the thrust of rotor 3, and after passing guide wheel 7 the water reaches the fourth impeller 8, which balances rotor 1. The water is then discharged into pipes through diffusor 9. Besides the exceptional balancing thus obtained, this system claims as its greatest advantage the relief of the pressure stuffing box from maximum pressure, one end being formed by the suction pipe, while the other end is formed by

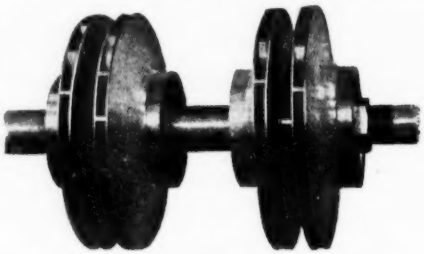


FIG. 15. FOUR WHEELS OF THE OLD TYPE SULZER PUMP ARRANGED PAIR-WISE.

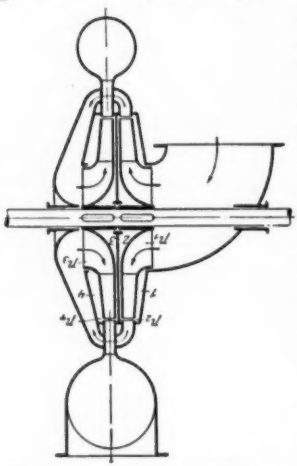


FIG. 16. SCHEME OF SULZER HIGH-LIFT TURBO-PUMP, OLD TYPE.

the discharge chamber of the by-pass channel filled at the pressure of the medium stage.

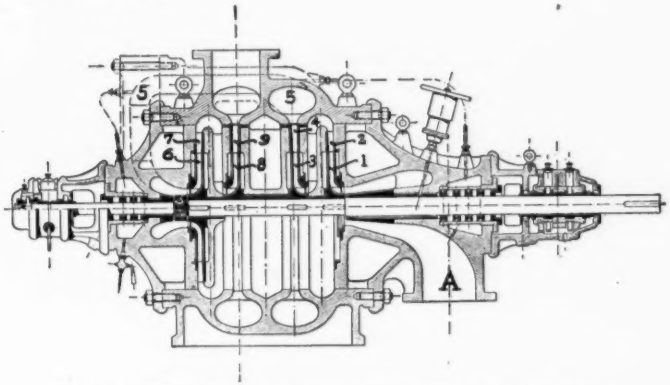


FIG. 17. OPPOSED GROUP BALANCING IN A WEISE & MONSKI PUMP.

Both systems have the common advantage that nearly all the additional and incalculable dynamic axial forces that can possibly arise are always balanced automatically, as the thrust of one wheel is always equal and opposed to that of its partner. Abnormal one-sided thrusts may yet occur. They must occur whenever the constructor is forced to choose an odd number of stages. Under such conditions there is aways left to these systems the possibility of balancing this uncompensated thrust by one of the means treated of in the following paragraphs:

As we have already seen, the amount of axial thrust is expressed by the formula

$$P = (D_1^2 - d^2)\frac{\pi}{4} \times (p_C - p_A)$$

The only ways to eliminate it, therefore, (if we discard the method of dividing it and opposing one-half to the other) are first, to reduce to zero the factor

$$(D_1^2 - d^2)\frac{\pi}{4}$$

or, second, to reduce to zero the other factor

$$(p_C - p_A).$$

Taking up these alternatives in order, we find first that among the several systems of altering the areas on the two sides of the rotors, only the Rateau method (Figure 18) has attained importance. This also, however, has now been abandoned by the licensees. The reason for this abandonment is the impossibility of fitting the clearances (S S, Figure 18) with sufficient accuracy, especially with multi-stage pumps. Moreover, during the process of transmission of energy, the friction between the fluid and the interior walls of the pump is not merely that due to its relative speed (as is the case when the wheel is covered on both sides), but that due to its absolute velocity, which is many times as great. Rapid wear and tear and considerable energy losses are the result. Again, a system like that shown in Figure 19 is self-condemned. The rotation of the disc with diameter D′ must occasion a friction loss many times as great as that of the ordinary rotor.

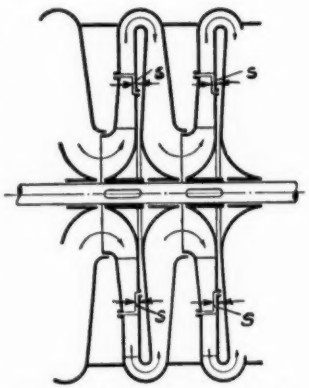


FIG. 18. SCHEME OF THE RATEAU HIGH-LIFT TURBO-PUMP.

The second method—that is, the elimination of the second factor in the formula for axial thrust—is the one most employed. It is not only apparently the simplest solution, but one generally known and traditional in turbine engineering.

The second factor is reduced to zero if the boss chamber of the impeller is connected with the impeller entrance, and an equalization of pressure in both chambers is thus effected. Figure 20 shows the construction schematically. It shows further that by this method the constructor may also provide against additional axial forces which might eventually develop; that is, he may make the diameter D′ a little larger than D″. The weak point of this generally adopted method of balancing is that its effect is completely altered if wear and tear exceeds a certain limit.

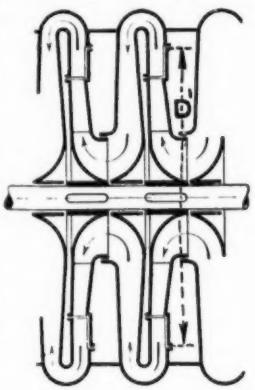


FIG. 19. THE LANG PUMP.

Considerable volumes of water escape through the clearance S, causing of themselves direct volumetric losses and giving rise indirectly to energy losses; for the direction of their motion is directly opposed to the entering stream of water and they will inevitably cause for the formation of vortices. Furthermore, the pressure in K is reduced and wholly uncontrollable axial forces are developed, leading usually the destruction of the thrust bearing.

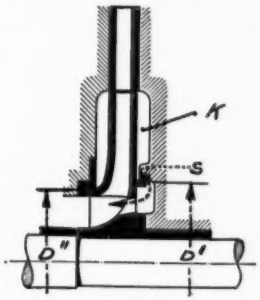


FIG. 20. CONNECTION OF BOSS CHAMBER AND IMPELLER ENTRANCE.

The excellent type of Jaeger-Worthington pump proves nevertheless that it is possible to master these difficulties. Its success is due primarily to the effective additional balancing patented by Mr. C. H. Jaeger and employed by Messrs. Worthington & Co. as his licensees. The system is shown schematically in Figure 21, and its leading principle is as follows: The wheels, together with the shaft, have a certain limited lateral movement in either direction. If from any cause an axial thrust develops, for example to the left, the whole set moves to the left. By this movement the edges of the discharge opening of the impeller are displaced, as shown in Figure 21. The conical form of the guide-wheel entrance now causes an enlargement of the clearance into the left-hand chamber, while that on the right remains unaffected. The result is a rush of water into the left-hand chamber, with consequent increase of pressure there, so that the wheel is forced back toward its original position, and after a few oscillations the rotor adapts itself to a new medium position. The necessary lateral shifting of the shaft is, nevertheless, combined with a fully effective collar thrust bearing for the requisite supplementary action.

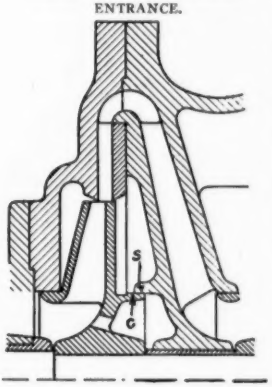


FIG. 21. JAEGER-WORTHINGTON SYSTEM.

The constructional features of this bearing are illustrated on page 708 in the schematic diagram (Figure 22). A is the collar bearing, which is interchangeably fitted to the shaft. The thrust collars

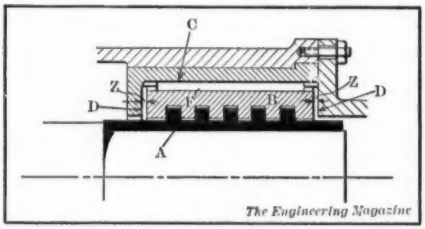


FIG. 22. JAEGER'S SHIFTING THRUST BEARING.

are not supported by a fixed babbit, the bushing B being simply cylindrical and secured against rotation only by the feather F. It can shift longitudinally along this feather F in the real bushing C, either to the right or to the left and to the extent of the clearances Z Z. Not until it has taken up one of these clearances and reached the shoulder D does the supporting effect of the collars begin.

While the Jaeger system provides each single wheel with its own piston-like balancing mechanism (the cylindrical surface C, Figure 21), the group balancing methods, to be described next, replace these several single pistons by a common one. Most of the balancing methods now depend upon this latter scheme. Pure piston balancing is illustrated by Figure 23, showing a pattern originally adopted by the Berliner-Maschinenbau Actiengesellschaft, formerly Schwartzkopff. The maximum pressure of the pump bears against a piston K whose other face projects into the chamber L. This latter chamber communicates by a small by-pass with the atmosphere or with the suction chamber of the pump or with any other stage as desired. Thus, by the constructor's design or by the control of the pump man, the counter-pressure may be graduated to any desired point. The finest gradations, even, may be secured by opening or closing more or less a stop-cock in the by-pass. The method of operation of this piston will be clear without further explanation. The vulnerable point of this design lies in the supposition of perfect tightness of the journal and stuffing box S. As this becomes worn a considerable loss of water at least may result, while at the worst the mechanism completely loses its effectiveness. And another fault must not be overlooked, and that is sluggishness in meeting momentary thrusts which may occur as we saw, for instance, merely by change in the delivery. The firm just mentioned has, therefore, lately altered the device in a direction which corresponds to that followed by the new axial thrust balancing adopted by Messrs. Sulzer Brothers. This last might be described as the most perfect balancing method yet applied.

Indeed, it was necessary for the Sulzers to develop a balancing system which should meet all requirements when the new Sulzer-

type wheel was introduced, for they renounced the method of balancing by simple opposition. Grave reasons of design, manufacture, and operation induced them, instead, to connect all the stages in one pump in series and all in the same direction, without balancing the single wheels. This course was adopted only because the constructors could place firm confidence in their new balancing system. The construction exhibited in Figure 24 at first glance resembles the piston-balancing already described. The distinguishing feature is that the regulating clearance S_1 extends radially instead of axially. Chamber b can be filled with any necessary pressure exactly as with true piston balancing. Chamber a is filled with water under the pressure of the

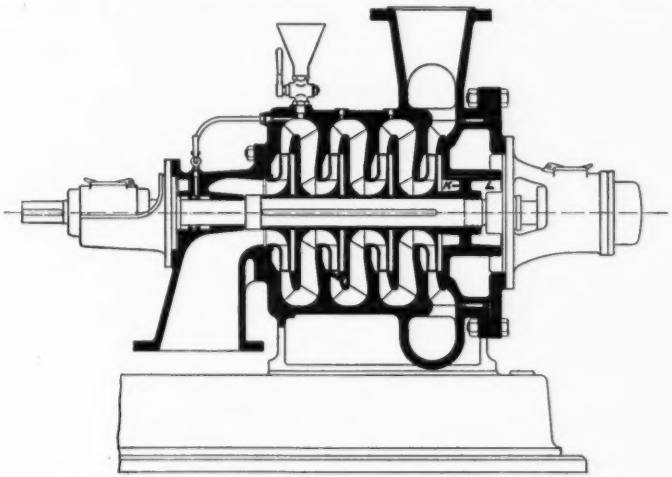


FIG. 23. PISTON-BALANCED MULTI-STAGE HIGH-LIFT TURBO-PUMP, SCHWARTZKOPFF TYPE.

highest stage through the clearance S. If any axial thrust to the left develops, the area of S_1 diminishes relatively to that of S. More water enters a than leaves it. The pressure in a therefore rises and opposes the axial thrust. If the axial thrust diminishes, the higher pressure in chamber a moves the whole set of wheels to the right. The area of S_1 is increased and more water escapes from chamber a through S_1 than is supplied through S. The pressure in chamber a falls and equilibrium is restored. If the balancing discs are made of large enough diameter there is no danger that their edges may run metal on metal at S_1. To understand this point we need only remember that if the opening S_1 were completely shut the pressure in a becomes

exactly that of the highest stage. If the exterior diameter of the disc is correctly fixed every possible thrust will be compensated by a corresponding pressure in a. That is, there must be a movement of the disc toward the right and consequently an opening at S_1. This arrangement can fail only if sand or dirt carried with the water should grind actual channels into the edges of the balancing disc, thus allowing considerable quantities of water to escape from a, even though the higher points on the edge touch the opposite metal ring. As an offset to this, must be considered the further advantage that the surafce at S_1 may be replaced easily, quickly, and cheaply, and can be made of any suitable material. If the apparatus should be defective the pump itself will not be in danger, for the centrifugal flow of water in chamber A provides constantly an ideal cooling effect. The balancing disc, in fact, is a perfectly cooled collar thrust bearing, and, indeed, since Sulzer Brothers introduced this device they have completely abandoned any auxiliary thrust bearing. The construction is proof against normal general wear and tear, as the opening S is kept as small as circumstances require by the thrust forces themselves.

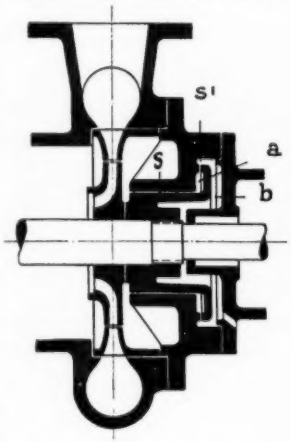


FIG. 24. SULZER BROTHERS' BALANCING DISC.

In summing up all balancing methods, we may say that *every compensation for axial thrust must be paid for by the equivalent consumption of a certain quantity of water.* The point of the matter is just there: It is inherently impossible to apply any force to a rotating discoid body except through providing an opening by which a certain quantity of the medium under pressure may continually escape, and this loss must be replenished if we wish to keep the force constant. That balancing method is the best in which this volumetric loss is as free as possible from attendant wear and tear, for in such case the loss from that cause at least cannot grow excessive. The volumetric loss in new pumps of good design does not usually exceed 1 per cent of their normal delivery.

ORGANISATION BY PRODUCTION FACTORS.

By H. C. Alexander.

V. The Method of Apportioning Indirect Expense by Production Factors.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," the third to "The Elements of Land Factor" and the fourth to "Buildings, Heating and Ventilation, Stores, and Organisation."—The Editors.

IN the preceding articles the general plan of the production-factor method has been, so to speak, roughed out. Two main principles have emerged, *viz.*, the reduction of non-productive work to different classes of "services" rendered to actual production, and the grouping of all indirect expense into these *natural* classes instead of into purely *accountancy* classifications such as the consolidation of all charges for depreciation, for rent, for interest, for repairs, etc., etc., irrespective of the purposes for which these charges were incurred.

The general point of view has been established that indirect expenses are incurred for the most part in connection with the exercise of certain special functions that the manufacturer assumes for his own convenience, but which are quite distinguishable in their nature from manufacturing proper—the landlord function and the power-supplier function being good examples. The expenditures incurred in performing these functions being readily distinguishable, it follows that they can be expressed as separate factors of production.

Certain of these functions may be called "separable" inasmuch as they are not *necessarily* carried on by the manufacturer himself, and in many cases are not carried on by him—simple rents for premises, or for power supply, being paid to outside persons in return for the services in question. On the other hand, the same principle has been extended to certain other functions, such as "organisation" and "supervision," that are always exercised by the manufacturer himself, and never contracted for with outside parties. It has been shown that these latter classes of expense can be treated on the same basis

as the separable functions, that they form well-defined and distinct services to production, and that, consequently, they also can be expressed as factors of manufacturing.

It will now be necessary to consider the meeting-place of the production factors (representing the cost of the various "services") with the actual and direct processes of production. As has already been indicated, this meeting takes place at the production-centres themselves, and the "burden," made up of a number of different items, is discharged on to the work *at the point of the tool.* The latter phrase so well illustrates an important principle that it is advisable to consider more closely the idea that it suggests.

If profit is to be made anywhere in manufacturing it must be made at the point where the tool touches the work. Unless an expenditure subserves, in some way, the efficient operation of the tool on the work, it is wasted expenditure. In as far as it does not subserve it in the most economical manner it is wasted expenditure. Given any particular kind of work to be done, there will be a maximum number of services and a maximum cost of those services necessary to the correct performance of the work, and anything beyond this is waste. The tool point is therefore the focus to which all expenditure converges, and to the operation of which all activity is subservient. It is obvious therefore that if we can find a means of expressing the value of these services *in terms of the time of operation of the tool,* we shall be near a very complete understanding and a very strong control of the whole process of manufacture.

The several factors of production, as we have already defined them, may be exhibited in their relation to production centres as follows:

PRODUCTION-CENTRE FACTORS.

Land-Building Factor.....	Incident by.....	Floor area.
Power Factor.....	"	Horse power used.
Lighting Factor.....	"	Floor area.
Heating Factor.....	"	Floor area.
Stores-Transport Factor.....	"	Special determination.
Organisation Factor.....	"	Simple division.
Supervision Factor.....	"	Special determination.

In addition to these services, another group of expenditures exists, arising out of the character of the production centre itself and the necessity for maintaining its functions in efficient activity. First among these are the charges arising from the capital value of the machine, *viz.*, interest and depreciation. Secondly, the amount ex-

pended from time to time to keep the machine up to the standard of working efficiency, *viz.*, repairs. Thirdly, an allowance for oil and waste, commonly proportioned according to the size and nature of the machine. Fourthly, a tool charge, representing the value of tools consumed in the ordinary working and the cost of grinding and sharpening them. In certain special cases a fifth charge is recognized, representing the wear and maintenance of jigs and templates, where these are an essential part of operation, as in press tools and stamping machines. These additional factors may be summarised as follows:—

INDIVIDUAL FACTORS OF PRODUCTION CENTRES.

Insurance, Interest and Depreciation on Capital Value.
Average cost of maintaining and repairing.
Oil, Waste, and Stores sundries Allowance.
Tool-room charge.
Jig and Template charge (in special cases).

It will be obvious that these are entirely localised factors, that is, they cannot by any stretch of imagination be considered as having any relation to any other production centre or to the work done on any other such centre. The average cost of maintaining and repairing, and the tool-room charge, are in the first instance dependent on determination by judgment; but by the aid of control accounts which will be explained in the next article, these and other factors are prevented from straying very far from substantial accuracy, though in fact careful preliminary determinations will be generally in practical accordance with the facts.

Assuming now that all these factors have been carefully tabulated, and the special determinations necessary have been made by competent authorities, it will be difficult to avoid the conclusion that we have here an actual incidence of indirect expense at the tool-point. Had such a method been in use early in the history of manufacturing it is inconceivable that it could have become superseded by any of the existing systems of lumping together all the different items of expense, and then plastering them over work indiscriminately on either a wages-value or an hour-value basis. All such methods would appear to be the substitution of vagueness for definiteness, and it is fairly certain that they would never have been even discussed.

It will, however, be seen at once, by those familiar with these matters, that this exactness of incidence is wholly dependent on a normal working period. If, for instance, in settling our factors we

assume a regular working of fifty 54-hour weeks in the year, equal to 2,700 working hours per annum, it is obvious that if some of the production centres are unemployed for a part of the time, all the indirect expenses of production incurred in the shop will not be distributed. This is true; but before describing the remedy, let us look at what this condition of unemployment really means.

In the first place it means waste. Though it may be unavoidable, and imposed on the shops by force of circumstances, it none the less remains waste. The particular kind of waste involved is waste of manufacturing resources. The fully organised shop represents capacity for manufacturing; its idleness therefore represents wasted capacity for manufacturing. A well recognised feature of indirect expense is that it remains stationary through considerable fluctuations of the volume of work passing through the shops. The production-factor method shows us very clearly why. Under the most urgent pressure of circumstances certain of the factors cannot be reduced at all, and others could only be reduced with great disturbance, and loss of elasticity and of efficiency.

Unemployment of production centres means therefore that a certain portion of the services maintained for the purpose of assisting production is running to waste. This circumstance, however, *does not affect the value of those services to the production still going on.* They remain as before. The production centres actually working take up no more room, do not consume more or less power, and require the same amount of supervision whether the others are idle or working. It seems obvious, therefore, that though in one sense and looking at the shop as a whole the cost of the whole volume of production is actually higher, (and the percentage of indirect expenses to labour on the old averaging methods would rise in proportion to the idleness of machines), yet the cost of the work that is being actually done really consists of two entirely distinct portions, *viz.*, (1) the normal cost, due to the call on services at the tool point, and (2) another portion that simply represents waste. This latter item really represents, in fact, *the incidence of indirect charges on work that was* NOT *done.*

THE SUPPLEMENTARY RATE.

However carefully the incidence of the various services at the tool point may be determined, it is an absolutely necessary element of accurate representation of the facts of production that some provision be made for keeping the cost of wasted time and resources separate from normal costs. The alternative to this is a loss of the

advantages which this separate determination of factors gives, and a fall to the level of average or percentage systems. It is even somewhat questionable whether any imperative necessity exists to express this waste as an element of the cost of jobs at all. Strictly speaking it is no part of such cost. If for example only half the machines in a shop are working, half the resources of the shop, roughly speaking, are being wasted. Under any percentage system the incidence of indirect charges on the work actually going through, would be, roughly, doubled. On the production-factor plan, the incidence at the tool point, on the work actually going through, would remain unchanged; but the balance of wasted resources would be known as a separate amount and expressed as a *separate* percentage of the normal cost, if desired. Which of the two plans is the most truthful, and which is the most useful? Surely the one that keeps the normal incidence unaltered and expresses the waste separately.

In practical working this is effected by what is termed a "supplementary rate." The relation of such a rate to the normal cost must of necessity be arbitrary, for it is not in itself a cost at all, but merely *the ratio of wasted capacity to utilised capacity*. In all percentage systems this wasted capacity is mixed up and charged along with utilised capacity as an increased total incidence of expenditure. No doubt one of the reasons why the practical mind has looked coldly on all burden-distributing systems is an unconscious perception that they cease to mean anything definite as soon as there is any departure from full time and normal working.

The determination of the supplementary rate is a very simple matter. The total amount that should be transferred to the work by all the machines in a given shop working full time being, of course, known, the difference between this total and the actual amount distributed in any given period, say a month, will represent a total of wasted resources in that shop. Its relation to the work actually done can then be expressed by a simple ratio, and the basis of this ratio is a matter of no great consequence. A simple and convenient plan is to express it in the form of an hour-charge—that is, so many cents per hour actually worked. Under any circumstances the rate is simply a memorandum of the ratio of waste to production. It is in no sense a cost, since it can afford no information of service either for estimating or for comparison with past or future jobs of the same kind. It merely represents the accidental circumstances of the shop during the period, and to that extent is a barometer of conditions.

It may be asked, why go to the trouble of distributing it? There is in fact no particular advantage in doing so from the costs standpoint. As it only represents *the elimination from normal costs of something that would otherwise conceal them,* any significance that the ratio possesses can be just as well expressed by a single monthly total made known to the responsible parties. Its distribution is in fact a concession to those who like to see every item of expense "distributed" over work, without regard to whether such distribution teaches anything or not. The principle involved will be made clearer by a tabular statement:—

ELEMENTS OF PROCESS COST, WHERE EVERYTHING IS DISTRIBUTED.

Labour, expressed as an hourly wage rate.
Utilised expense, expressed as an hourly rate at the tool point
Supplementary rate, being idle machine incidence for the period (month) expressed as an hour rate.

It will be obvious that when the costs of all work done in the month are taken, the total expense will have been charged to it in two portions, *viz:*—

TOTAL SHOP EXPENSE IN A GIVEN PERIOD.

Utilised expense, transferred to work at tool point.
Wasted expense, transferred to work per Supplementary Rate on an hour value basis, as a separate element of cost.

It must not be overlooked that the ratio of wasted to utilised capacity is, in itself, a most important and significant figure, and if the production-factor method did nothing more than make this ratio known it would give advantages not otherwise to be attained. It is a figure of the utmost interest to the management, but whether anything is gained, *from the costs point of view,* by expressing it as a portion of individual costs is as stated above a matter open to argument. If we decide in favour of its distribution over work, it will be for reasons that have relation to accountancy and financial bookkeeping rather than to the use of costs as costs. The best that can be said for the plan from the costs point of view is that it forces the accidental conditions of the shops into prominence, and so prevents them being overlooked. But in reading such costs, the true meaning of this rate, viz., *waste,* must be kept steadily in mind. With this proviso there is no objection to its inclusion as a separate element of cost.

Generally speaking there falls into the supplementary rate all expenditure for which no return is obtained. Examples of this sort of

outlay are suggested in the items listed below. This list is not exhaustive but will indicate the class of expense so treated. The rate being primarily a waste rate, all expenditure in the nature of dead loss falls into it.

Idle machine incidence.
Spoiled work.
Removals and rearrangements of plant, fixtures, etc.
Loss caused by stoppage of power plant.
"Extra" payment for overtime.

Practical Settlement of Machine Rates.

The entire range of methods by which expense is localised and brought to a focus at the tool point having now been enumerated, the practical settlement of the machine-rate factors will be considered next, and afterwards the nature of the arrangements that secure the keeping of such factors in touch with changes of organisation or circumstances of manufacturing.

The relation of expense incidence to production centres is shown graphically by the following diagram, in which the factors above the dotted line represent "overhead" burden, properly speaking, and those below represent the incidence peculiar to each individual tool.

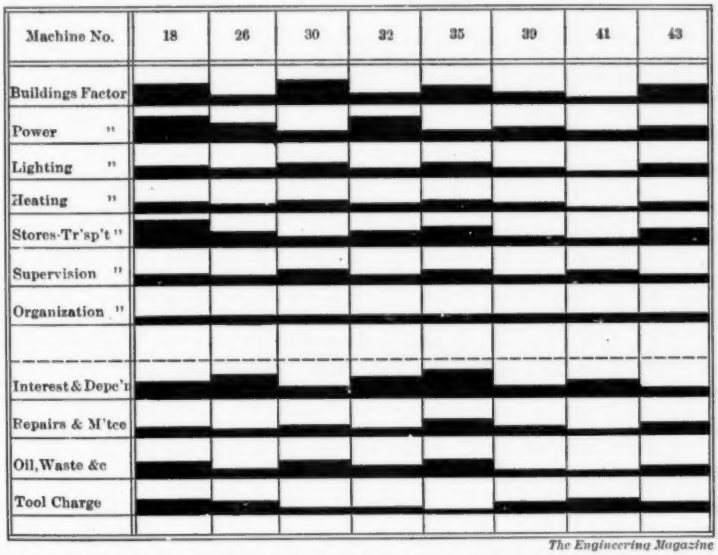


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FIG. I. DIAGRAM SHOWING RELATIVE ABSORPTION OF FACTORS BY THE DIFFERENT PRODUCTION CENTRES IN A SHOP.

Schedule of _____ Shop Factors & Machine Rates

															Shop Totals per Annum	
1. Description																
2. Machine No.																
3. Space Occupied																
4. Power Absorbed																
5. Capital Value																
6. Depreciation Rate																
7. Buildings Factor																
8. Power Factor																
9. Lighting Factor																
10. Heating Factor																
11. Stores-Transport Factor																
12. Supervision Factor																
13. Organization Factor																
14. Interest, Depe'n & Ins'ce																
15. Repairs & M't'ce																
16. Oil & Allowance																
17. Tool Room Charge																
18. Yearly Total for 2700 Hrs.																
19. Hourly Rate																

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FIG. 2. SCHEDULE OF DISTRIBUTION OF EXPENSE ACCORDING TO PRODUCTION FACTORS.

In this diagram the vertical columns represent machines, and the horizontal lines represent the relative amount of each factor taken up, on the various bases of assessment, by each machine. If plotted strictly to scale, integration of the black portions vertically would necessarily give the relative differences of the resulting machine rates, while integration along the horizontal lines would give the total expense due to each factor that has to be borne by the shop. The object of the diagram is however merely to give a graphic realisation of the way in which different machines absorb factors in different proportions and it also serves to demonstrate how very far from the truth any "averaging" system of distributing burden must be. We shall now proceed with the practical methods used for determining the figures that are represented in this diagram of black rectangles.

In settling actual figures a schedule similar to Figure 2 is employed—a separate one, of course, being used for each shop. This schedule contains as many vertical columns as there are production centres in the shop. Items 1 to 6 represent data respecting each machine. Items 7 to 13 provide spaces for the monetary value of the incidence of each factor on each machine. Items 14 to 17 provide for the charges peculiar to each production centre on its own account. The vertical column at the right hand summarises the total amount that will be distributed of each factor when the shop is working the full amount of 2,700 hours, or whatever the usual working year may be.

The settlement of Items 7, 9 and 10, presents no difficulty. They are ascertained by a simple multiplication of the factor that has already been ascertained in terms of annual unit value per square yard, (or per square foot, which is more convenient) by the number of square feet occupied by the machine as set out above in Item 3. The power factor is ascertained in the same way by multiplying the unit value per horse power by the number of horse power absorbed as Item No. 4. The organisation factor will already be known, inasmuch as it is in the first place ascertained on a unit basis per production centre. The interest depreciation and insurance factor, Item 14, is most conveniently dealt with by means of an amortisation table (referred to in connection with the land factor in the third article). The value of the machine being known, its duration of life, say 10 years, is fixed by a competent authority, the residual or scrap value deducted from the original value, and the remaining value can then be treated as a 10-year terminable lease, at 4 per cent or 5 per

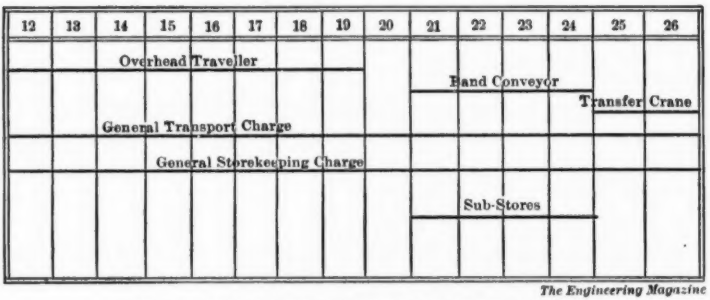


FIG. 3. LOCALISATION OF STORES-TRANSPORT FACTOR.

cent interest as the usual local practice demands. This usual interest is increased to an amount sufficient to cover the insurance, so that the three items of interest depreciation and insurance can be dealt with in one annual factor, which will be an equal amount every year until the end of the assessed life of the machine.

Items 11, 12, 15, 16, 17, will then be left for settlement. Each of these is what may be called a "judgment" factor; that is, its allotment to particular machines cannot be reduced to a formula or universally applicable rule, but must depend on careful examination of the relative claims of each machine in the shop, in the case of Items 11 and 12, and on an advance estimate of actual requirements in the case of the others. One thing, however, must be pointed out. The error must not be made of supposing that because these factors are termed "judgment" factors, they are therefore to be regarded as simply "guess" factors. The method of settlement now to be described, if carried out by competent persons, will realise a very high ratio of accuracy, though slight modifications may be considered desirable from time to time.

Settlement of Stores-Transport Factor.

It will be remembered that in the last article the lines on which the factor is departmentalised were indicated. The question was left at this stage—"The result of this preliminary mapping out of the field of stores-transport will be that each department will have:—(1) a share of the general stores-keeping expense proportional to the bulk of its transactions, (2) a number of particularised charges already seen to be connected with groups or kinds of production centres." The narrowing down of the departmental share entails two separate processes—localisation and allotment. Figure 3 shows the nature of the first process. The vertical divisions represent all the production centres in the shop. Across all these we draw two

lines, representing respectively general storeskeeping and general transport charges, some portion of which will be allocable to every machine. Facilities that are confined to special groups of machines are plotted next. The method of doing this will be seen by the diagram, where the short lines represent craneage, conveying, and sub-stores *of which the operation concerns only the product of those machines across which these lines are drawn.* Having thus localised the elements, the next step will be to give proportional value to the incidence so indicated.

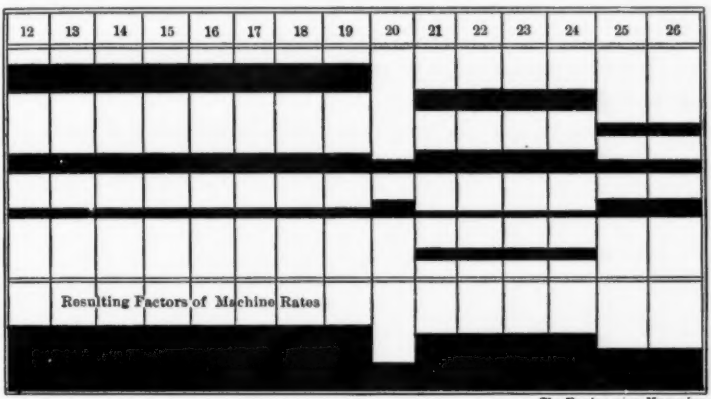


FIG. 4. APPORTIONMENT OF STORES-TRANSPORT FACTORS.

This definite allotment is shown by Figure 4. It is assumed that this will be drawn on squared paper, to scale, in such a way that vertical distances are proportional to values expressed in money. The localised items are dealt with first. The expense of the overhead traveller, for instance, being considered equally incident on machines 12 to 19, and being concerned with no other machines in the shop, the localisation line of that item is thickened so as to indicate the proportionate share to be borne by each machine served by it. The other localised items are then dealt with in the same way. A survey is next made of the general storeskeeping charges. On examination it will probably be found that variation in the bulk and quantity of product exists as between particular machines and groups of machines. Those, for example, which entail frequent call on the services of the stores department will obviously be allotted a heavier share than others. Thus heavy machine tools, on which a job lasts several days will claim less of the stores department's time than machines making product for stock in quantities. A careful comparison

of the kind of work carried on by each machine in relation to the class of expense included in the general stores-keeping expense will lead to a close and satisfactory apportionment of that expense between the different machines.

The same plan is followed with the general transport charge, which, it must be remembered, does not include the special transport arrangements represented by the short lines on the diagram. Generally speaking it will be found that this item is not a heavy one after the special facilities have been localised out. But whatever the amount is, it is allotted between the various machines in proportion to their use of the services it represents.

The subsequent aggregation of the black portions of the diagram, if they have been drawn to scale, will yield rectangles of different heights as shown at the foot of Figure 4, and these when transmuted into their money equivalents will provide the figures necessary to insert in the schedule of machine rates against Item 11.

The Supervision Factor.

The localisation and allocation of the expenses comprised in this factor are dealt with in the same way as the stores-transport factor. The wages of "leading hands" and of inspectors, are made incident on those machines to which they refer. The general expense, including proportion of works manager's salary and office expense, and that of the shop foreman, is then distributed to the various production centres on the basis of a careful consideration of their relative claims, having regard to the nature of the processes carried out at each of them. Thus some machines, as for instance a group of automatic machines under the charge of a leading hand, (whose wages would already have been localised to that group) would bear relatively little of the general expense of supervision. Acquaintance with the run of the work of the shop and the ordinary routine of the foreman will make the task of the relative determination of this class of burden a compartively simple one. The *method,* being precisely similar to that just described in connection with stores-transport, need not be further elaborated here.

The Remaining Factors.

The maintenance and repairs factor is arrived at by an estimate of the average annual expense of keeping the machine in good condition under ordinary circumstances of "fair wear and tear." This

will not be a difficult figure to arrive at, if we admit that the cost of any wholly unforeseen catastrophe such as breakage is in the nature of a dead loss, and should be charged not against the machine, but against the "supplementary rate." The determination must obviously be made, as in the case of all these factors, not by an accountant but by an engineer.

The charge for oil, waste, and sundries of this class is usually based on a definite allowance of such stores made by regulation, and under the record and control of the storeskeeper. It is therefore a figure that presents no difficulty.

The tool-room charge includes the supply of cutting tools, and the sharpening and maintenance of them. It will obviously vary considerably on different classes of machines. It must be so fixed as to represent fairly the average consumption of tools. In the case of expensive milling cutters of large size it will be high; in the case of a hack saw, trifling. A close approximation to the actual cost will however be made if careful consideration is given to the usual run of the work on each machine.

The schedule being now completed, it remains only to aggregate the various factors that have been debited to each production centre and divide the total amount by the number of working hours per annum. The resulting figure is the hourly machine rate. It is sometimes urged that machine rates should be averaged into classes, so as to have three or four groups instead of a number of different rates. Such a contention is, of course, an absurd one. There is no more difficulty in having a number of diverse machine rates than in having a number of different rates of wages. It is just as easy to calculate one rate as another. The proposal is no doubt due to the "averaging" microbe that seems so difficult to eliminate from all questions of indirect charges.

In the next article the nature of the control accounts that keep the various fixed factors in touch with the actual expenditure they represent will be explained, and a general view of the working of the method will be given, diagrammatically and otherwise.

STACKS FOR WATER-TUBE BOILERS.

By T. F. J. Maguire

Mr. Maguire's article has the same purpose as his preceding contributions on "Grate Areas for Water-Tube Boilers" and "Boiler Efficiencies with Various Kinds of Fuel," which appeared in our issues for October and December, 1909. This is to express the data of efficiency in fuel combustion by concrete formulæ available for reference and use by power plant owners or operators.—THE EDITORS.

THE function of a stack is to supply the furnace with the proper amount of air for the combustion of the fuel and to convey the products of combustion over the heating surface of the boiler The pressure or intensity of draft produced by a stack is due to the difference in weight between the column of heated gases in the stack and a column of equal height of the surrounding air.

The available draft of any given stack is consumed in the following manner: (a), in supplying sufficient pressure between the ash pit and the top of the fuel bed to drive the necessary amount of air through the bed for the combustion of the fuel; (b), in overcoming the friction and inertia of the gases in passing over the heating surface of the boiler; (c), in overcoming the friction losses due to the passage of the gases in the breeching. The available or effective stack draft must be equal at all times to the draft losses in furnace, boiler setting, and breeching, and therefore a knowledge of these losses and of the output at which the boiler plant will operate, will furnish the necessary data for determining the height and diameter of stack.

FURNACE DRAFT.—The intensity of draft required in the furnace depends upon the fuel, the kind of grate or stoker used, and the rate at which the fuel is consumed. In the case of coal, the furnace draft depends upon the percentage of fixed carbon in the coal, upon its caking tendency and size, upon the amount of ash in the coal and its tendency to form objectionable clinkers, and upon the thickness of the coal bed carried upon the grate. The higher the percentage of fixed carbon in the coal, the more draft is required to burn the coal. An anthracite coal will require more draft than a semi-anthracite, and a semi-bituminous less than a semi-anthracite, while a bituminous coal requires the least draft of the four. Coals of large size do not form as compact a mass as the same coals of finer sizes, and hence for a given thickness of bed, offer less resistance to the passage of the air.

Coal of nut size will require less draft than run-of-mine, and the latter less than when the coal is in slack form. With coals high in ash, there is a comparatively rapid increase in the accumulation of the ash on the grate and a consequent increase in the resistance to the passage of the air. Coals that form objectionable clinkers are difficult to burn successfully, owing to the tendency of the clinkers to fill the air openings in the grates. With fine sizes of coal, it is necessary to have comparatively small air openings through the grates in order to prevent excessive loss of fuel, and consequently the resistance to the passage of the air through the grate is relatively large. For any given coal, an increase in the thickness of the bed requires a corresponding increase in the draft. It is evident from the above that the proper furnace draft for any given case depends upon a number of conditions, and that the results obtained from experience are alone valuable in determining the proper furnace-draft intensity.

While it is an easy matter to cut down the furnace draft at any time, it is not economically possible to increase it beyond a certain value dependent upon the size of stack. For this reason care should be taken, in estimating the furnace draft required, to base this upon the poorest grade of fuel that is likely to be used and the maximum output at which the boiler plant will operate for any given length of time. As an illustration, a certain plant might contemplate the use of nothing but high-grade, Eastern bituminous coal in run-of-mine form. It would not be wise, however, in this case to determine the dimensions of the stack on this basis, but rather on the basis of a low-grade bituminous, or even semi-bituminous coal, in slack form, that might be obtained in the market safely and at a reasonable price. Other things being equal, the lower the grade of coal used, the greater will be the first cost of the stack; and it is therefore advisable, in determining the stack size, to assume a coal as little inferior to the coal that is to be commonly used as is consistent with safety in plant operation.

The table on the following page gives what are believed to be safe values for furnace draft, in inches of water column, for various coals and rates of combustion. These values of furnace draft are applicable to flat grates of the stationary, rocking, and dumping types. The values are also applicable in many cases for inclined-grate type of stokers and chain grates. Knowing the lowest grade of coal that is likely to be used in a given plant, together with the maximum boiler horse-power that is to be developed, it is a very easy matter to ascer-

tain the maximum rate of combustion or number of pounds of dry coal to be burned per square foot of grate per hour, and hence from the above table, the maximum furnace draft to be provided for

DRAFT REQUIRED IN FURNACE.

Kind of Coal.	Pounds of dry coal burned per square foot of grate per hour.						
	15	20	25	30	35	40	45
Eastern bituminous coals	.12	.16	.20	.27	.34	.42	.52
Western bituminous coals	.15	.20	.25	.33	.42	.52	.65
Semi-bituminous coals	.15	.20	.28	.37	.48	.60	.80
Anthracite buckwheat No. 1 and larger	.45	.70	1.00				
Anthracite buckwheat No. 2 and No. 3	.75	1.30					

LOSS OF DRAFT IN BOILER SETTING.—The loss of draft in the boiler setting depends upon the arrangement of the baffles, upon the load carried by the boiler, and upon the cleanliness of the path followed by the gases. The principal draft loss in boilers of the vertical-pass type occurs in the middle pass where the gases are compelled to move downward, when the natural tendency of these hot gases is to rise. The pure friction loss in the boiler passes is usually not over one-half the total loss due to friction, turns, and downward motion of the gases. The net sectional area between the tubes may be varied considerably without causing any appreciable change in the draft loss in boiler setting. As an illustration, two vertical-baffle boilers of the same general arrangement and horse power, and with the same number of horizontal rows of tubes, will give practically the same draft loss with space between tubes in horizontal rows varying from 1⅝ inches to over 3 inches. A considerable amount of soot may collect in the boiler setting and on the heating surface without causing an appreciable increase in draft loss. An accumulation so excessive as to choke up space between tubes will, of course, throttle the draft. It is, however, always advisable to keep the interior of a setting clean, as well as the heating surface of the boiler if best draft and economy are to be maintained. Experience would seem to indicate that for all ordinary water-tube boilers, an allowance of 0.3 inch of water column is ample for draft loss in boiler setting with boilers developing not over 25 per cent in excess of rated capacity, and 0.4 inch of water column for an overload of 50 per cent.

LOSS OF DRAFT IN BREECHINGS.—The loss of draft in a breeching depends upon its length, the number of turns that it makes, and its cross-sectional area and perimeter. The material of which a breeching is constructed also has an influence upon the draft, the loss of

draft in a brick flue being about one-third more than in a steel or iron flue. The cross-sectional area of a breeching should be made not less than the area of the stack to which it joins. Of course, where a breeching is connected to a number of boilers, it is not necessary to keep the area of the breeching the same throughout its length, but the area may be dcreased in proportion to the boiler capacity supplied. For a circular steel or iron breeching, having an area equal to the stack or larger, or decreased in area in proportion to the boiler capacity supplied, it is customary to allow 0.1 inch loss of draft per 100 feet of length, and for each right-angle turn an additional draft of 0.05 inch of water column. For square or rectangular breechings (if adjacent sides do not differ more than in the ratio of 2 to 1) of steel or iron, the allowance given above for circular flues should be increased 25 per cent. The brick or brick lined flues increase the above figures 30 per cent.

Available Draft Intensity and Height of a Stack.—Having determined the maximum horse power at which the boilers are to operate for any given length of time, the poorest grade of coal that is likely to be used, and the relative location of stack and boilers, it is a simple matter to fix upon the draft to allow for the furnace, for loss in boiler setting, and for loss in breeching. Adding these three, the result is the intensity of draft that must be supplied by the stack at the point where the breeching enters stack. In a well designed stack, the available draft intensity is practically equal to 80 per cent of the theoretical value and is expressed by the formula:

$$D = 0.42 \text{ H.P. } (\tfrac{1}{T} - \tfrac{1}{T_1}), \text{ in which}$$

H = height of top of stack above the grate in feet.

D = available draft in inches of water column.

P = atmospheric pressure in pounds per square inch.

T and T_1 = absolute temperatures of the outside air and gases in the stack respectively. The absolute temperature is simply the temperature in degrees Fahrenheit plus 460.7 degrees.

At sea level P = 14.7 pounds, and for average conditions the atmospheric temperature may be assumed equal to 70 degrees F., and the temperature of the gases in the stack at 550 degrees F. Substituting these values in the above formula, the relation between the available draft intensity in inches of water column and the height of the stack in feet is given by the relation

$$D = 0.0055 \text{ H, or}$$

$$H = \frac{D}{.0055}$$

It is believed that this simple formula is sufficiently accurate for most practical cases at or near sea level. For altitudes higher than sea level, the height of stack as obtained from the above formula should be multiplied by the ratio of the barometric pressure at sea level to the barometric pressure of the altitude under consideration. In order then to obtain the height of stack in feet above the grate, add together the estimated draft-intensity losses in inches of water column in furnace, boiler setting, and breeching, and divide this sum by the constant 0.0055.

DIAMETER OF STACK.—Assuming that 20 per cent of the draft intensity created by a stack is lost in friction in the stack itself, that the average temperatures of stack gases and outside air are 550 degrees F. and 70 degrees F. respectively, and that each pound of fuel generates 18 pounds of gases, it may be readily shown that the diameter of a round steel, unlined stack is given by the following expression:

$$d = 2.12\ (C_h)^{\frac{2}{5}}, \text{ in which}$$

d = diameter of stack in inches,

C_h = pounds of dry coal consumer per hour under conditions of maximum load and when using the poorest grade of coal that is likely to be used in plant.

If HP represents the *rated* capacity of the boilers supplied by the stack, f the overload factor (for 50 per cent overload $f = 1.5$) and E represents the evaporative ability of the coal or the number of pounds of water from and at 212 degrees F. evaporated per pound of dry coal at the stated overload, then the above formula for diameter may be written in the form:

$$d = 8.76 \left(\frac{f\,H\,P}{E} \right)^{\frac{2}{5}}$$

The two formulae for stack diameter given above are sufficiently accurate for most practical cases at or near sea level. For higher altitude, the diameter as obtained from either of the above two formulae should be multiplied by the 2/5 power of the ratio of the barometric pressure at sea level to the barometric pressure of the altitude under consideration. For masonry or lined steel stacks, increase the above diameter 5 per cent.

The following examples show the practical application of the above. A certain boiler plant is to be installed, consisting of ten 400 horsepower water-tube boilers, and the plant is to be capable of operating at

an overload of 50 per cent. Boilers are arranged in five batteries and discharge into a single stack, the latter being located between the third and fourth batteries. The breeching is straight, and its length from stack to boiler farthest removed is 100 feet. The grate areas are designed for the use of a fair grade of Eastern bituminous coal and are 1/50 of the heating surface of the boilers. Upon investigation, it is found that the poorest coal ever likely to be used at the plant is a bituminous slack capable of evaporating at overload 7.5 pounds of water from and at 212 degrees F. per pound of dry coal. As the overload is estimated at 50 per cent, the maximum load in the boiler plant will be 6,000 horse power. As a boiler horse-power is equivalent to an evaporation of 34.5 pounds of water per hour from and at 212 degrees F., the number of pounds of dry coal burned per hour, with the plant developing 6,000 horse power and using the slack assumed above, will be 27,000 pounds. The heating surface of water-tube boilers is practically ten times the rated horse power, and therefore the combined grate areas of these boilers will be 800 square feet. At 50 per cent overload, the rate of combustion of the above coal, or the number of pounds of dry coal burned per square foot of grate per hour, will be 34.5 pounds. By reference to the table given for furnace drafts, the corresponding furance draft intensity is 0.34 inch of water column. The loss in boiler setting is 0.4 inch of draft and the breeching loss to farthest boiler is 0.2 inch for unlined iron breeching of suitable cross-section, there being of necessity two right-angle turns, one at the boiler and the other at the stack. Adding these three draft losses, it is evident that the available stack draft intensity must be equal to 0.94 inch of water column. Dividing this last figure by the constant 0.0055, the required height of stack above the grates, for unlined iron stack, is found to be practically 170 feet. The stack diameter as found by either of the two above formulae is 127 inches. The total breeching areas at the stack should be equal to the stack area, at least for circular unlined breechings. As the stack for the plant under consideration is located between the third and fourth batteries, the breeching to the three batteries should be 75 square feet at the stack and the other breeching 50 squart feet, the two breechings decreasing in cross-section proportionally to the boiler horse power carried.

A certain boiler plant is to be installed and is to consist of 400 horse-power water-tube boilers arranged in batteries of two, each battery being supplied with a stack placed directly over the boilers. The grate areas are equal to 1/32 of the heating surface, and it is required

that the draft be such as to enable the rated capacity of the boilers to be developed using anthracite No. 3 buckwheat coal, the evaporative ability of this coal being estimated at 7.0 pounds of water from and at 212 degrees F. per pound of dry coal. At rated capacity the boiler output per battery will be 800 horse power and to develop this rating, the hourly consumption of No. 3 buckwheat will be 3,943 pounds of dry coal. The grate area of the battery of boilers will be 229 square feet, and consequently the rate of combustion of the No. 3 buckwreat, at 800 horse-power output, will be 17.2 pounds. The furnace draft required will be practically 1.0 inch of water column and the loss in the boiler setting about 0.3 inch. As there is no breeching, the stack must provide an available draft of 1.3 inch and the height of stack must be therefore 1.30 ÷ .0055, or 237 feet above the grates. The diameter of an unlined steel stack would be equal to 58 inches. It is probably more effective and efficient to burn the anthracite buckwheats by means of forced draft, a blower creating sufficient pressure in the ash pit to provide the necessary furnace draft. The stack for such a forced-draft system would be of sufficient height to compensate for the draft losses in boiler setting and breeching.

For oil- and gas-burning furnaces, the draft lost in the furnace is practically negligible, and the stack height is simply based on the draft losses in the boiler setting and breeching.

INDUSTRIAL APPLICATIONS OF REINFORCED CONCRETE.

By M. M. Sloan.

Mr. Sloan's review began last month with an argument of the peculiar adaptability of reinforced concrete to industrial structures, and a statement of some of the principal elements of design. In this part, and in his following installments, he takes up specifically the details of floor, lintel, roof, and skylight design, and applications of reinforced concrete to equipment, foundations, reservoirs, and other of the less ordinary uses for which it may be employed.—THE EDITORS.

REINFORCED concrete is particularly applicable to the construction of foundations for important buildings of the loft or industrial type where the loads are heavy and the confines of the foundation plan are limited by the party lines.

Usually in large cities the laws regulating the building of party walls seriously interfere with the theoretical design of the foundations, and compel the employment of unusual methods in the design of this portion of the structure. This is especially true of reinforced-concrete buildings of the skeleton or frame construction type, where the loads are concentrated on reinforced-concrete wall columns or piers. Owing to the difficulties of obtaining proper party-wall construction with such a type of building, it is very desirable at times to build the foundation entirely within the party line; and where the adjoining wall is built simply to the party line there is frequently a material saving in cost by doing this; besides, the necessity of tearing out the neighboring wall and exposing the tenant in the adjoining building is avoided. When this condition occurs, reinforced concrete is a material admirably adapted to the design of foundations where the load is eccentric.

These conditions and the methods of meeting them are best understood by referring to Figure 6, which shows at "A" and "B" the two methods generally employed for the construction of heavy foundations against an adjoining wall. At "A" in the figure is shown a heavy foundation footing, in the nature of an inverted reinforced-concrete beam. Upon this the wall columns take their bearing, and transmit the load lengthwise of the foundations.

It is the best practice in the design of such foundations to calculate them in the same manner as spread footings, namely, as a canti-

lever extending from either side of the wall column. To insure action in this manner, it is necessary to cut through the foundations at intermediate points between the wall columns by inserting a board and breaking the continuity of the concrete. By doing this the action of the cantilever is insured, and the area of the foundation can be accurately determined. If this were not done, the beam would have to be reinforced top and bottom, as it would be uncertain, due to the lack of uniformity in the bearing soil, what reactions would occur on the footing running lengthwise of the building.

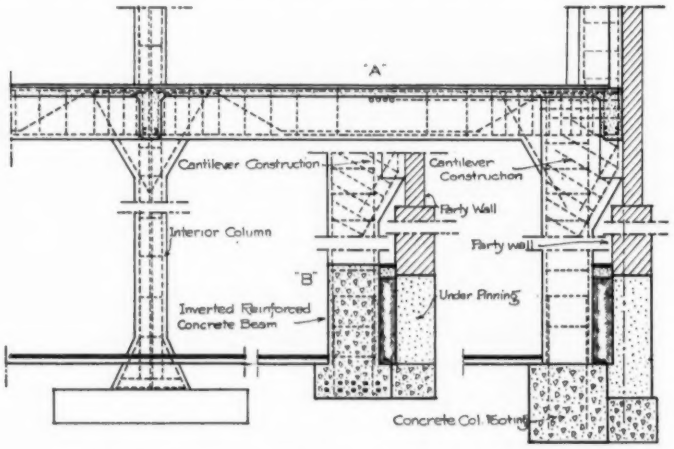


FIG. 6. REINFORCED-CONCRETE FOUNDATION CONSTRUCTION.

At "B" in the figure is illustrated a method which has been successfully employed in the design of buildings of ten and twelve stories. This detail shows the use of the reinforced-concrete cantilever at the first-floor level, which cantilever carries the wall columns above it and is arranged to transmit the load concentric to a spread footing beneath the basement floor. This is certainly the best means of distributing the load uniformly on the soil; but the cantilever must be very carefully designed, and usually such a mass of reinforcing steel is required in the cantilever that a weakness is likely to develop, for reinforced concrete is not dissimilar to cast iron, in that it is uncertain whether the material and workmanship realize the expectations of the designer, though the large factor of safety usually possessed by reinforced concrete is frequently its salvation.

A reinforced-concrete cantilever is designed in the same manner as the steel cantilever, which has been so extensively used in skeleton construction, and the beams at the first floor must necessarily be

heavy and strongly reinforced to transmit the upward reaction to the interior columns.

The use of reinforced concrete has instituted a considerable saving in the cost of foundations under interior columns in the construction of spread footings. A typical foundation for an interior column, in which a structural steel core is used to increase the strength, is shown in Figure 7. This is the simplest type of foundation construction, and there is a material saving in the cost of this over the cost of steel-beam grillage which was formerly of such general use in steel-frame building construction.

Many architects and engineers favor, for manufacturing buildings of limited light, spread footings extending over large areas and supporting several loads unsymmetrically placed; but spread footings, where the soil is extremely bad, have seldom been successfully employed, as it is impracticable to proportion them so as to obtain equal settlement, on account of the fact that the live load is a considerable proportion of the total load carried, and is always undetermined. This is true especially in manufacturing plants, where some portions of the building are doubly loaded and others have practically no live load. Besides, in manufacturing plants where stair towers, tank towers, and elevator shafts exist, spread footings cannot be designed theoretically correct, and the conservative engineer or architect would resort to pile foundations. In this construction, concrete, both plain and reinforced, is undoubtedly an ideal material for the piles, as it is entirely durable and has greater bearing strength than timber piles.

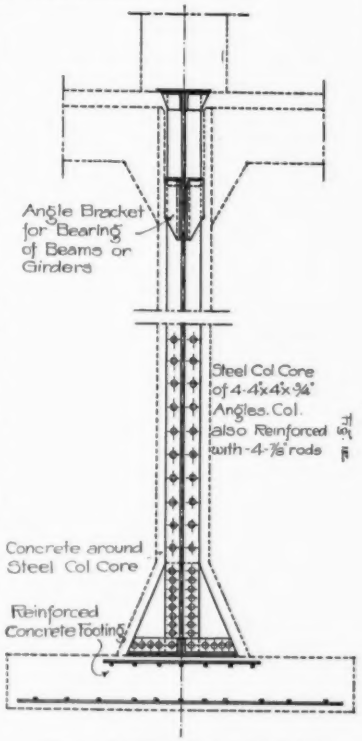

Angle Bracket for Bearing of Beams or Girders
Steel Col Core of 4-4"x4"x¾" Angles. Col. also Reinforced with 4-⅞" rods
Fig. 7
Concrete around Steel Col Core
Reinforced Concrete Footing

FIG. 7. REINFORCED-CONCRETE FOOTING AND INTERIOR COLUMN.

In the construction of such foundations, concrete piles both reinforced and without reinforcement have been successfully used, and

where the soil is of proper quality, underlaid with a hard stratum, there is no better form of foundation construction than concrete piles, either cast and driven or formed directly in the soil. A typical concrete pile foundation, such as would be used in the construction of a manufacturing or industrial plant, is illustrated in Figure 8.

FIG. 8. A TYPICAL REINFORCED-CONCRETE PILE FOUNDATION.

While reinforced-concrete piles are more costly than wooden piles, they are frequently less expensive than to sheet pile the excavation and run the piers down to a solid bearing with the attendent cost of pumping and expense of working in a heavy soil.

Another advantageous use of reinforced-concrete piles in the construction of industrial plants is for foundations under tank towers or stacks. In such places, the concrete pile can be reinforced with steel, and steel rods or bars can be embedded in the pile, extended up into the footings, and turned over so as to insure great anchorage and supply the necessary resistance for foundation or anchor bolts. A typical foundation of this kind for one of the supports of a 100,000-gallon tank tower is illustrated in Figure 9, showing the method by which the weight of the pile and the earth surrounding it are transmitted to the footing, and can be added in the calculation for the resistance of the upward reaction caused by wind pressure at the windward supports.

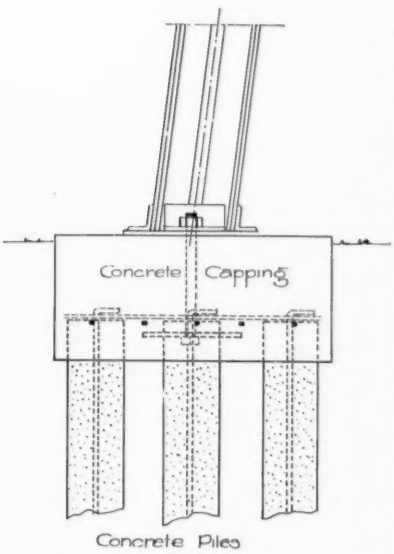


FIG. 9. TANK-SUPPORT FOUNDATION.

In the application of reinforced concrete to factory or warehouse construction, there has always arisen the question as to the best manner by which shafting, overhead trolley runways, or other installations may be secured to the concrete work. It is manifestly impracticable and expensive to drill into concrete work to get bolt fastenings, and, in fact, it is impossible to do this in the bottom of beams or girders, from the fact that in drilling the steel reinforcement is encountered, and all efforts to get a hold on the concrete are frustrated by the concrete spalling when the drill strikes the steel reinforcement. Consequently, it is the practice to embed at regular intervals in the concrete, iron sockets or fastenings to which wooden sleepers, channel irons, or other string pieces may be secured.

There are many types of these sockets or fastenings. Some of them depend for their strength on the grip which they have upon the reinforcing rods or bars, others merely on their bond in the concrete. In the selection of such sockets or fastenings the load to be carried must always be considered, and while for ordinary purposes a socket which is tapped out for a ¾-inch bolt is sufficiently strong, where shafting is heavy the size of the socket should be increased to ⅞-inch. Types of concrete sockets or inserts are illus-

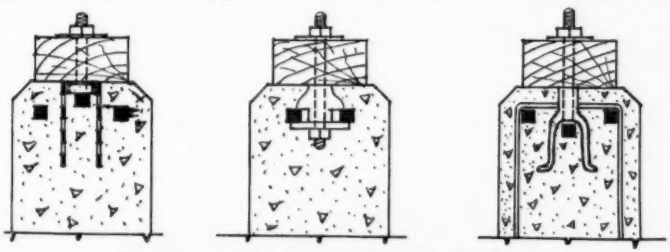


FIG. 10. TYPES OF CONCRETE SOCKETS AND BOLTS.

trated in Figure 10, and in all instances where the sockets are of equal strength there is little choice to be made in the selection.

The socket which is embedded in the concrete must always answer the purpose for which it is intended, namely, it must be of such a form that the steel rods or bars can readily be placed around it, and it is best when the socket is secured in the forms by a stud bolt, as then the verticality of the socket is assured. The socket, in all its parts, must have strength equal to the net section of the bolt which is intended to screw into the tapped portion; besides it must be so designed as to get ample grip or hold in the concrete construction to develop the net strength of the bolt.

The cost of reinforced-concrete buildings is greatly influenced by the character of floor finishes that are placed upon the reinforced-concrete slab construction. It is usual, in industrial or loft buildings, to provide either a cement floor finish or a hard-maple finished floor. In order to provide either of these finishes, properly constructed, it is necessary to put down upon the top of the reinforced-concrete floor slab a filling of either stone or cinder concrete to act as a binder for the cement finish, or as a material for the embedment of wooden sleepers for the securing of the maple floor. It is possible to put the cement finish directly upon the reinforced-concrete slab, but in doing this the cement finish must be placed shortly after the concrete is put in the forms, and also must be very carefully worked in with the slab construction; and it gives satisfaction only when great care is used in the construction of the work.

The best practice is usually considered to consist of placing a two-inch layer of cinder concrete, carefully mixed, laid and tamped, upon which the cement finish coat is laid and carefully troweled to a smooth surface.

Where a wood floor is desired, sleepers are laid upon the reinforced-concrete slab and filled in between with cinder concrete, the sleepers being held in place either by beveling them on the sides or by driving nails in the sides, letting them project so as to get a firm bond in the cinder fill.

The comparative cost of the several floor finishes greatly influences the cost of the building per square foot, and the comparative cost of manufacturing buildings with different floor finishes, of usual construction and of fair size, is given in the following table:

Reinforced-Concrete Slab—2-inch Cement Finish.....$1.25 per sq. ft.
Reinforced-Concrete Slab—1-inch Cement Finish on 2-inch Cinder Concrete.....$1.30 per sq. ft.
Reinforced-Concrete Slab—5/4-No. 1 Maple Flooring on 2-inch Cinder Concrete.....$1.35 per sq. ft.

There are many details in reinforced-concrete construction which are characteristic of this type of construction, and which are common to all characters of buildings erected of the type of skeleton reinforced-concrete construction. In Figure 11 an illustration is given which shows some of these peculiar features.

FIG. 11. ILLUSTRATING PECULIAR FEATURES OF REINFORCED-CONCRETE CONSTRUCTION.

Of principal interest is the reinforced-concrete structure extending above the roof for the support of the sprinkler tank. It is the common practice, where a building is supported by reinforced-concrete interior columns and exterior wall piers, and where the walls are merely spandrels or curtain walls, to provide support for large sprinkler tanks by carrying up four or more of the reinforced-concrete columns and connecting them with an arched head, and arranging beams or platforms for the support of the wooden tank for fire protection. In the design of such tank towers, as they are twenty-five or thirty feet in height above the top of the buildings, the additional stresses created by wind pressure must be considered, and it is best to have the top of the concrete columns connected by reinforced-concrete arch or knee braces well reinforced. Besides arranging for the support of the tank, the slab is usually extended from the sides of the tower to provide a platform around the tank for inspection and painting.

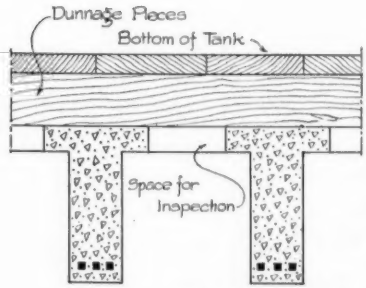


FIG. 12. TOWER PLATFORM.

It is best, instead of having a complete monolithic slab over the top of the tower, with no openings throughout, to form a construction as illustrated in Figure 12. By arranging the beams in this manner, the advantage of a tee section is obtained, and the space between allows for the inspection of the tank.

In this illustration are also shown knee braces inserted in the upper intersections between the wall columns and the lintel beams, in order to stiffen the building. While this is usually unnecessary in buildings of five or six stories in height, it is better practice to use them where the building is narrow and of more stories in height, and it is always good practice to provide these knee braces where the building is subject to the vibrations of machinery.

Since reinforced concrete insures a durable construction, with a minimum of deterioration, it is necessary, besides having an excellent foundation, to provide as nearly perfect roof covering as possible. It has been found that the most practical covering for the roof of a reinforced-concrete building is either slag or gravel roof, or a well manufactured prepared roofing.

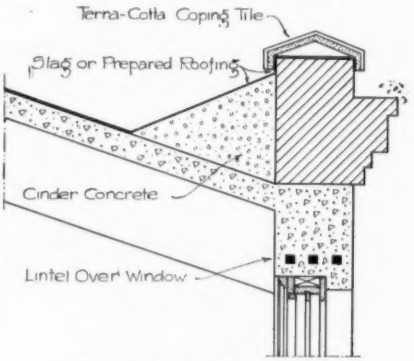
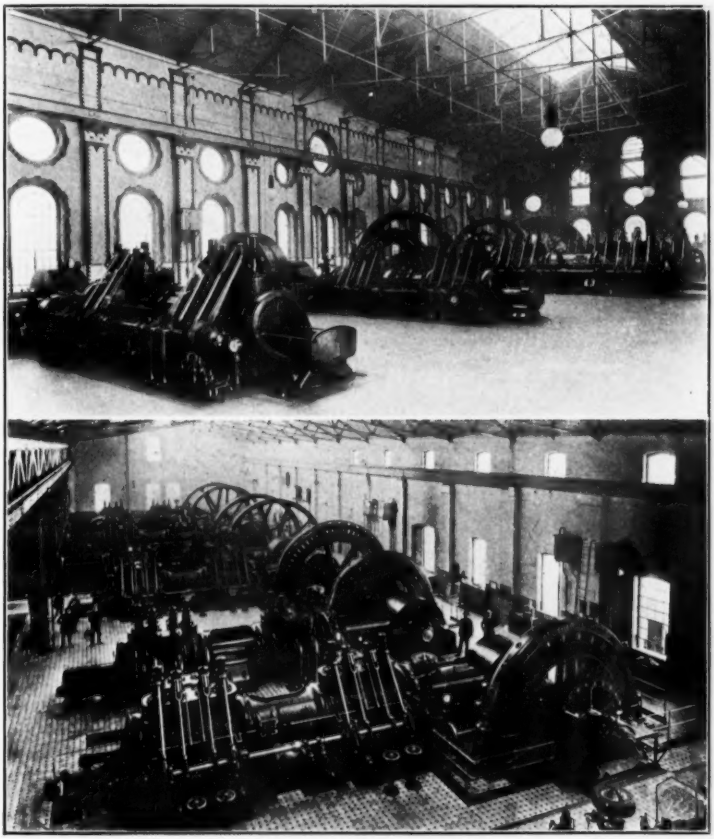


FIG. 13. ROOF AND GUTTER.

Owing to the cinder fill which is used in forming the gussets on a reinforced-concrete roof, tin plate has not been found of use either as a covering or as flashings, and the cheapest and most durable roof is provided when the felt or prepared roofing is formed into gussets on the top of the reinforced-concrete roof slab so as to conduct water to the eave boxes, and these gussets are arranged so that their upper edge is level with the top of the parapet wall. In this way the felt roofing can be carried underneath the coping tile, as illustrated in Figure 13.

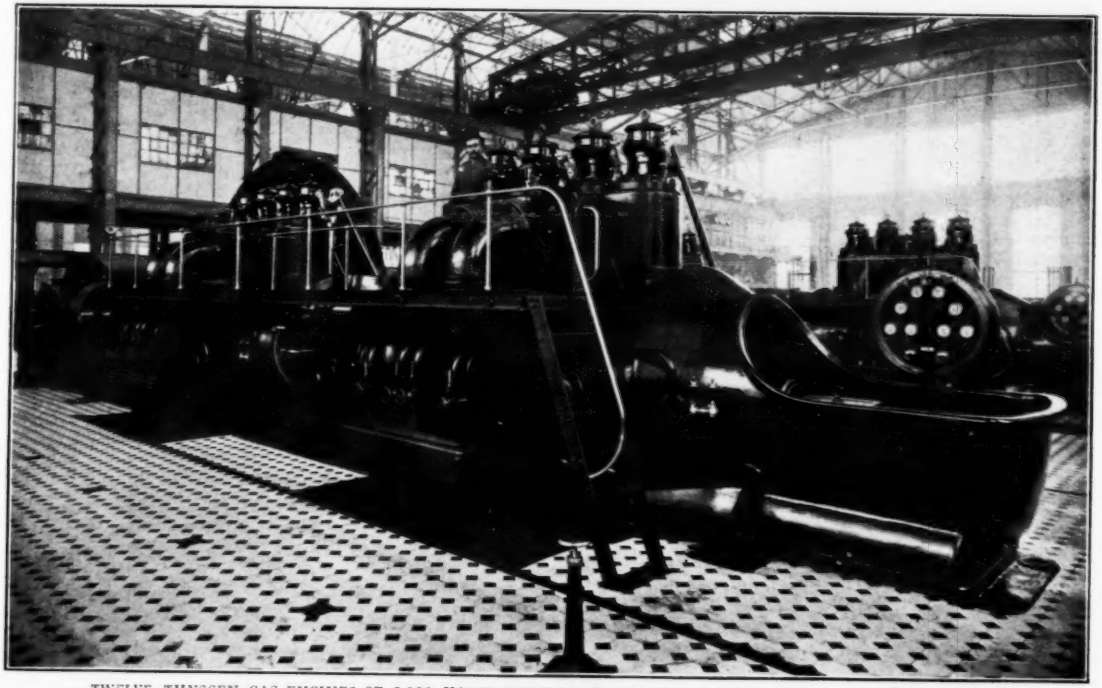
NOTABLE GAS-ENGINE INSTALLATIONS IN CONTINENTAL EUROPE.

A SERIES OF ILLUSTRATIONS WITH DESCRIPTIVE CAPTIONS.

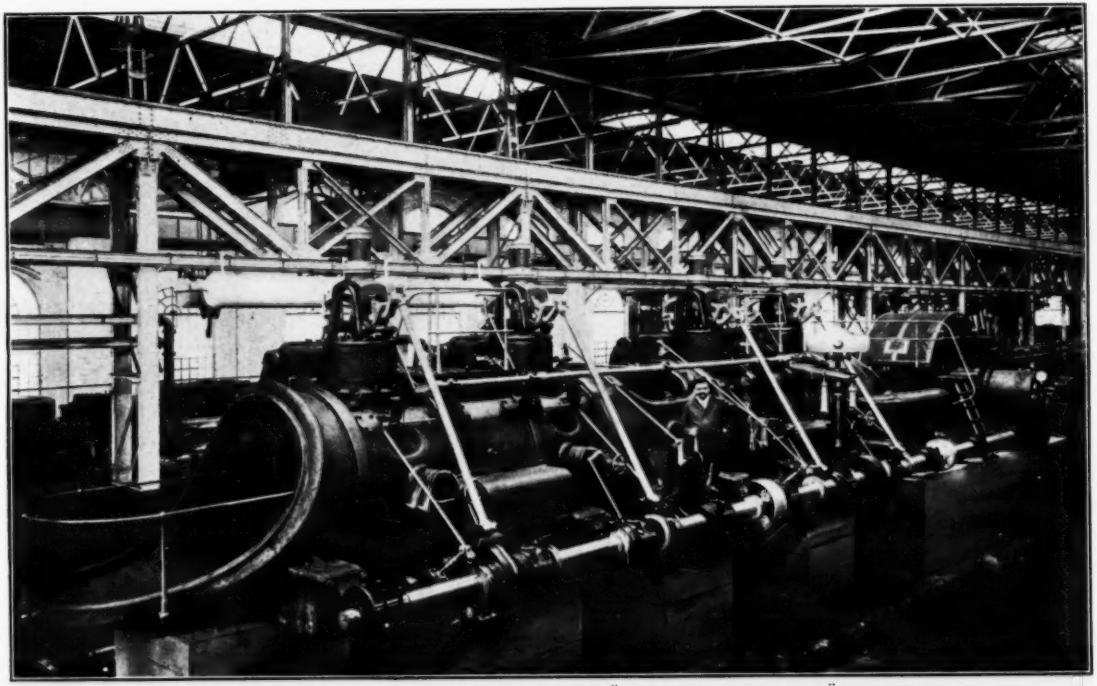


CHARACTERISTIC INSTALLATIONS OF LARGE NUREMBURG GAS ENGINES.

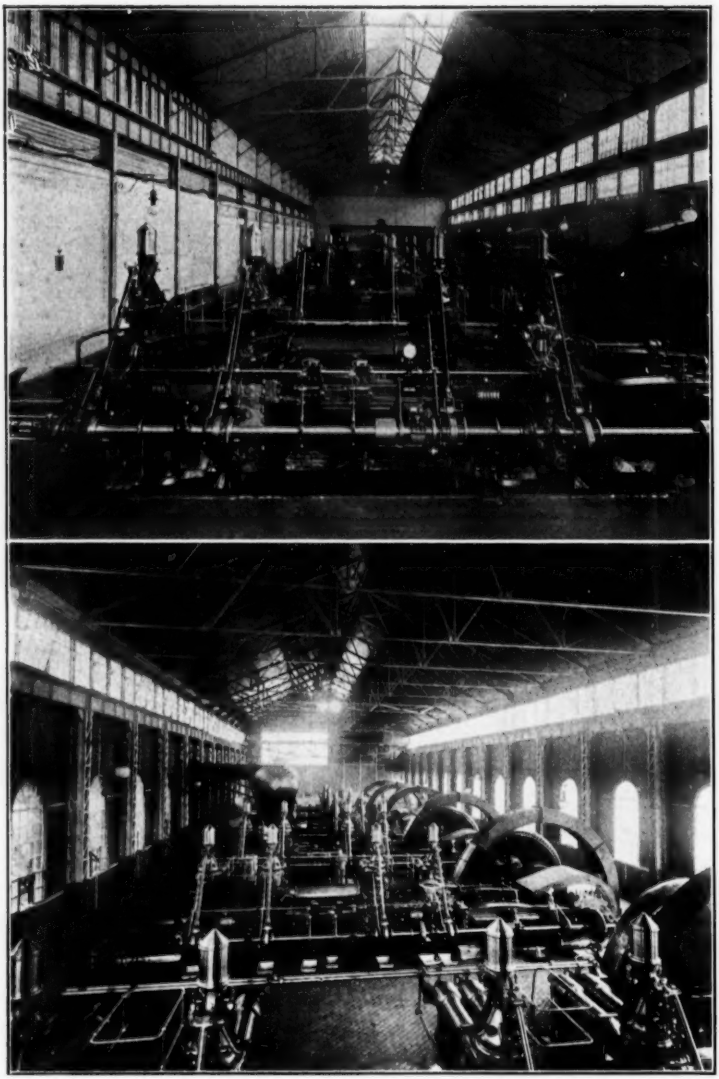
The upper picture shows a plant described as "the largest coke-oven gas-engine power station in the world." It contains nine units aggregating about 15,000 h. p., or developing from 1,000 to 2,800 h. p. each, coupled to three-phase dynamos. The lower view shows the power plant of the Rombach Hüttenwerke, with fifteen Nurnberg gas engines totalling 20,900 h. p. using blast-furnace gas and distributed thus: six blowing engines and nine gas-engine dynamo units, generating three-phase and continuous current.



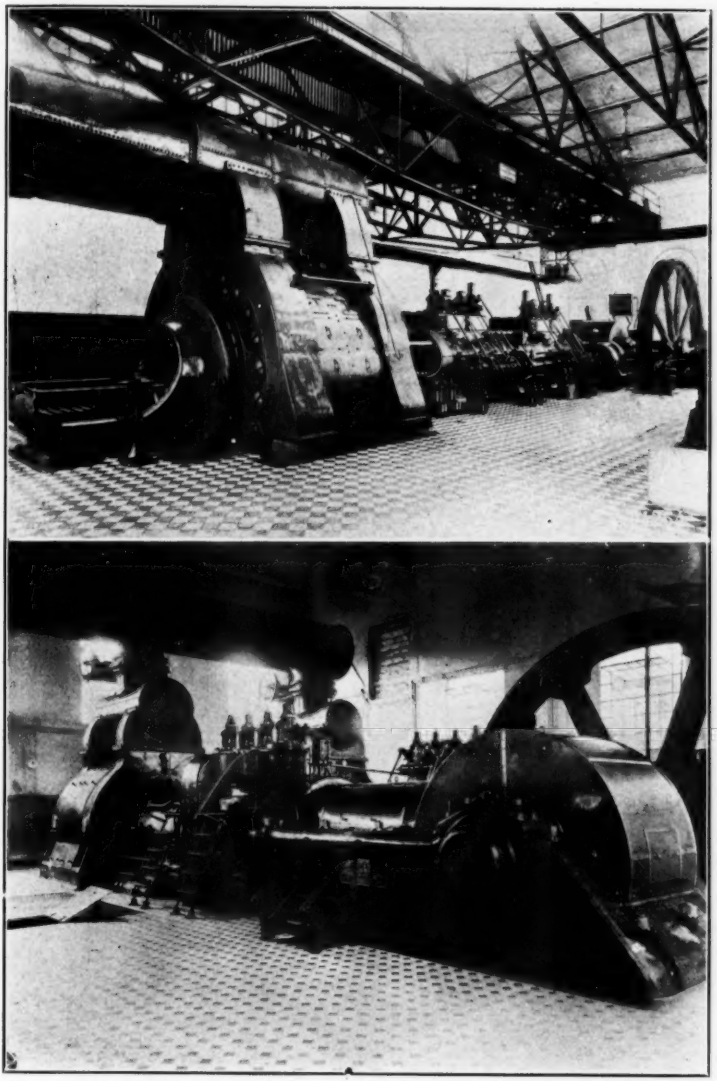
TWELVE THYSSEN GAS ENGINES OF 2,000 HORSE POWER EACH GROUPED UNDER ONE ROOF AT BRÜCKHAUSEN.



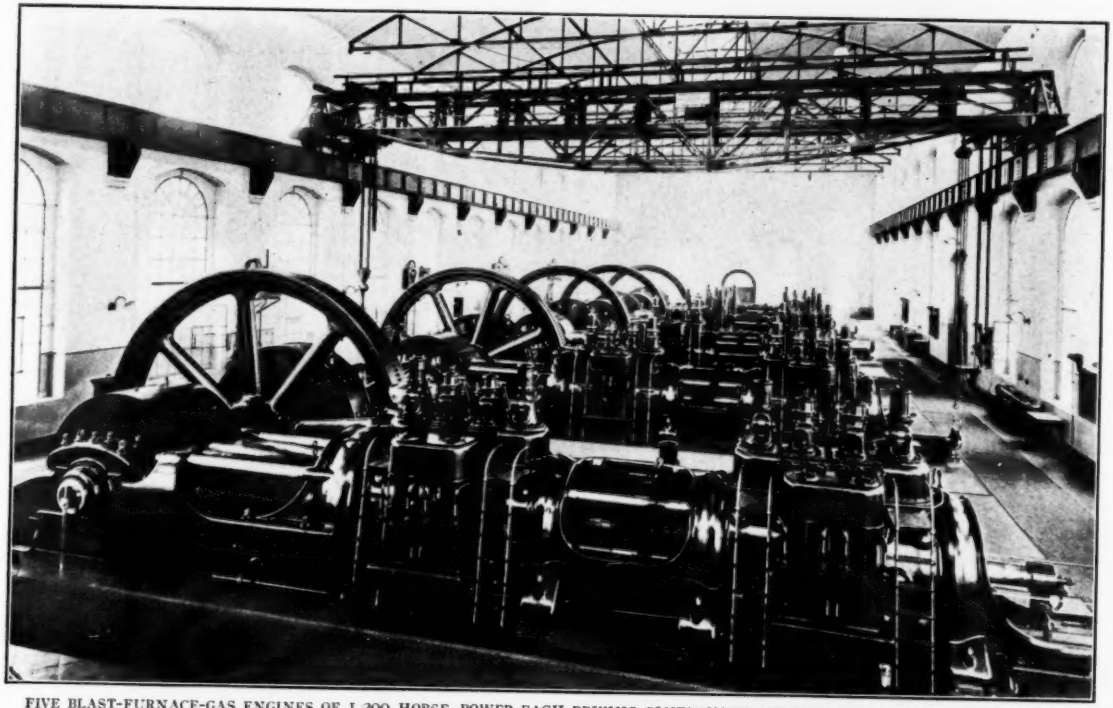
DEUTZ GAS ENGINE OF 2,000 HORSE POWER FOR THE HÖRDER BERGWERKS UND HÜTTEN-VEREIN.



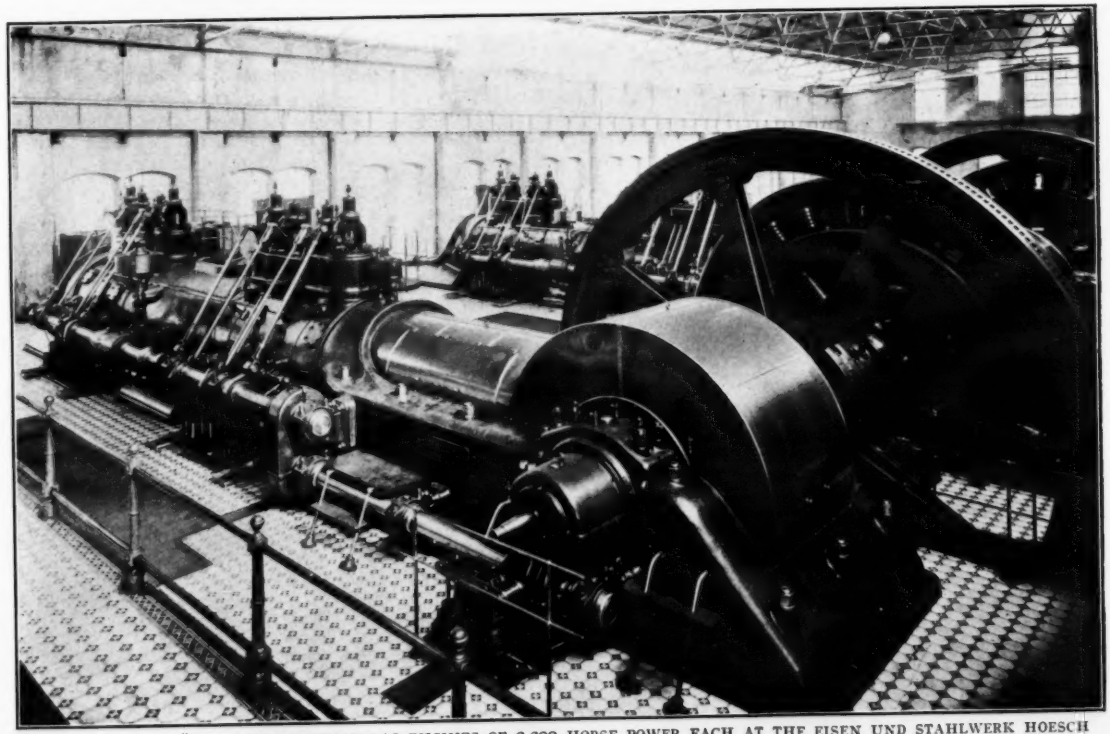
INSTALLATIONS OF COCKERILL GAS ENGINES. ABOVE, TWO SINGLE AND FOUR DOUBLE TANDEM MOTORS, TOTAL 7,000 HORSE POWER, AT THE COCKERILL BLAST-FURNACE PLANT. BELOW, THREE BLOWING ENGINES OF 600 HORSE POWER EACH AND THREE ELECTRIC GENERATOR UNITS OF 1,400 HORSE POWER EACH—6,000 HORSE POWER TOTAL—AT THE WORKS OF THE SOCIÉTÉ DE LA PROVIDENCE, MARCHIENNE-AU-PONT.



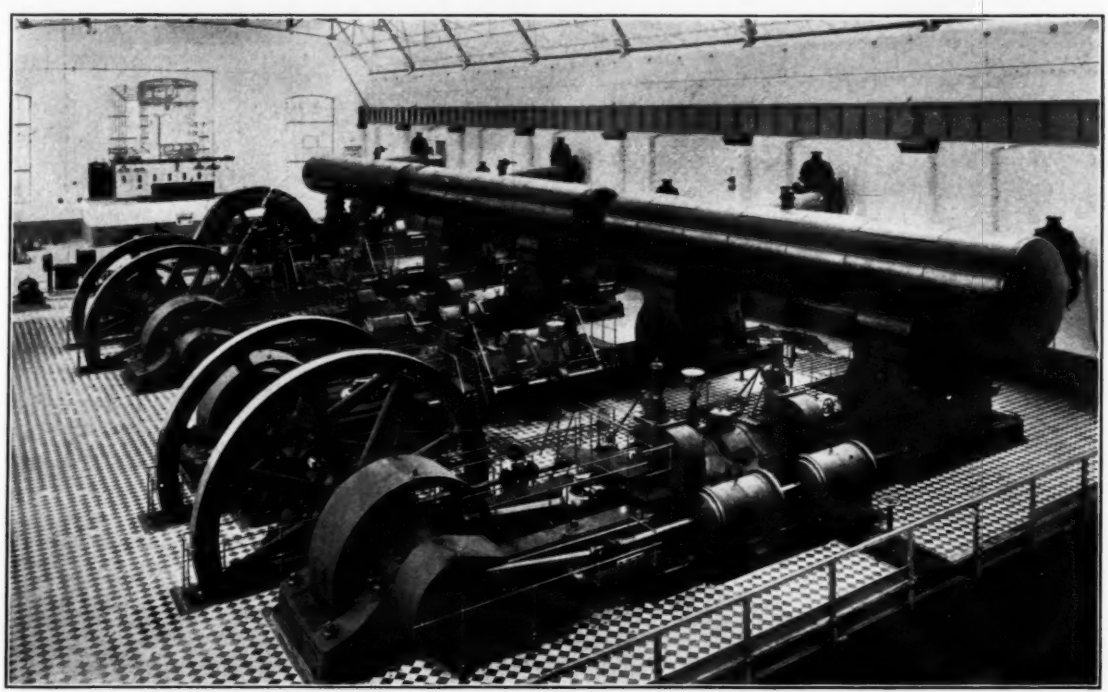
ABOVE, BLAST-FURNACE-GAS ENGINE OF 1,800 HORSE POWER, ROCKLING'SCHE EISEN UND STAHLWERKE, DIEDENHOFEN. BELOW, TWIN BLOWING ENGINE BY EHRHARDT & SEHMER, 1,000 HORSE POWER, INSTALLED AT THE BURBACHER HÜTTE. TWO ADDITIONAL MACHINES, ONE OF 1,000 AND ONE OF 1,400 HORSE POWER, ARE INCLUDED IN THE PLANS OF THIS PLANT.



FIVE BLAST-FURNACE-GAS ENGINES OF 1,200 HORSE POWER EACH DRIVING CONTINUOUS-CURRENT DYNAMOS, GEORGS-MARIEN BERGWERKS UND HÜTTEN-VEREIN, OSNABRÜCK.

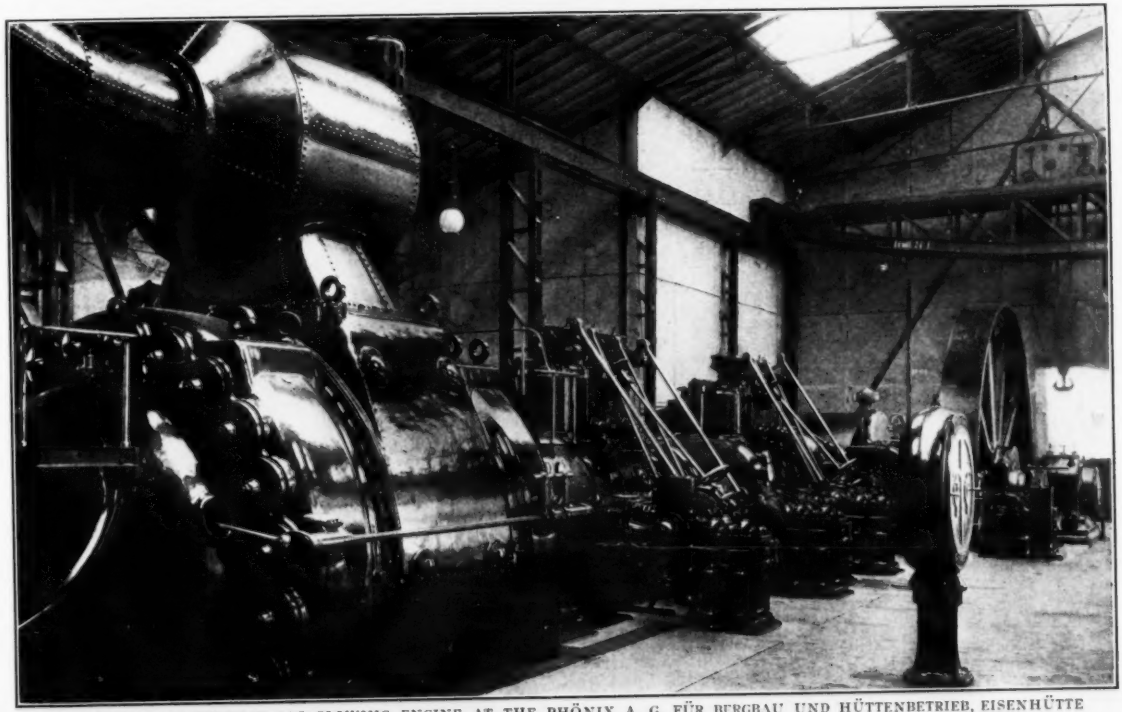


FOUR SCHLEIFMÜHLE BLAST-FURNACE-GAS ENGINES OF 2,200 HORSE POWER EACH AT THE EISEN UND STAHLWERK HOESCH AKTIENGESELLSCHAFT, DORTMUND.



FOUR TWO-CYCLE BLAST-FURNACE-GAS ENGINES MADE BY GEBR. KLEIN, COUPLED TO BLOWING ENGINES AT THE WORKS OF THE PETITSFILS DE FOIS DE WENDEL, HAYINGEN, LORRAINE.

Gas cylinder 30½ in., blowing cylinder 73 in., stroke 51¼ in., 18,000 cu. ft. air per minute at 70 revolutions.



THYSSEN BLAST-FURNACE-GAS BLOWING ENGINE AT THE PHÖNIX A. G. FÜR BERGBAU UND HÜTTENBETRIEB, EISENHÜTTE BERGE-BORBECK.

2,000 h.p., delivering 1,000 cu. metres of air per minute at 0.7 atmosphere; gas cylinder 1,100 mm, air cylinder 2,560 mm, stroke 1,200 mm, 80 r.p.m.

IMPROVING PRODUCTION CONDITIONS IN A MODERN BOILER FACTORY.

By H. S. Knowlton.

ONE of the most encouraging features of the work of improving the operating economy of industrial plants is the frequent possibility of reducing sources of waste by the expenditure of very small sums of money. This is particularly the case in the majority of new and well-designed plants, where, in the early years of service, there is ordinarily little occasion for extensive remodelling of the installation as a whole. In shops concerned with rapidly growing industries the individual tools are likely to undergo more or less change as commercial service continues, but if a plant is well laid out initially, the widest field for improvement usually lies in the direction of arranging the minor features of the installation to advantage—in taking up industrial lost motion, as it were, by the institution of a more perfect organization of men and materials, and by cutting down the waste of time at various points which were overlooked in the stress of starting the factory. Manufacturers are rapidly appreciating the importance of saving the greatest possible amount of time per job consistent with good work; they are becoming keenly alive to the cost of losing small amounts of material and supplies per day, multiplied into an impressive yearly total which is indisputably worth saving; and they are no longer slow to realize that sources of congestion and delay formerly accepted as necessary parts of the business become intolerable when subjected to the critical standards of modern practice.

Three years ago a new boiler shop was completed in a manufacturing city of the eastern States and was placed in service with the most modern equipment on the market. Many of the tools were electrically driven; compressed air was installed throughout the plant; liberal provision was made for the handling of material from the laying-out division to the shipping yard; and a first-class cost-stores system was inaugurated. Recently the plant was revisited for the purpose of comparing the establishment of today with that of 1906. Numerous improvements were in evidence, although

the general design of the shop was unchanged, the arrangement of the tools was practically as before, and not a single machine of high power had been added to the shop's equipment. The improvements were not of a striking character as a whole, but in relation to increased economy of production or saving in time and labor they were thoroughly representative.

Handling the company's product between the testing bay and the shipping yard was much improved by the installation of a 50-horse-power hoisting engine equipped with double drums. Formerly all the product of the shops was hauled outside by a steam locomotive owned by the connecting railroad company. The cost of this service was so great that work had to be allowed to accumulate inside the shops, so that a number of boilers or tanks could be handled in a single working period, in order to reduce the cost of handling per boiler. The tendency toward congestion, just beyond the testing bay, became troublesome, and the desirability of being able to move the product at the moment of its completion from the painting division to the storage yard became too great for inattention. The installation of the hoisting engine enabled the company to handle from one to a dozen flat cars at its own convenience, the attendance being limited to that of its own employees, and the services of the railroad company's shifting locomotive were required only when movements between the shops and the outer limits of the yard were necessary. With the hoisting engine and a 50-ton yard derrick installed when the shops were built, boilers are now quickly placed either on the track for immediate shipment or transferred to a stock yard for temporary storage. The interior of the shop building is free from congestion.

Another improvement in the handling of material was effected by establishing a casting yard within easy reach of the tracks leading to the main line of the railroad passing the plant. Formerly the various raw and machined castings were stored at scattered points throughout the shops, occupying valuable space in the vicinity of the machine tools, more or less imperfectly classified and requiring considerable time in selection. In the casting yard as now arranged one side is set apart for the reception and weighing of the unfinished parts prior to machining, the other side containing completed castings in orderly groups ready for immediate transfer to outgoing trains. Assembly on the cars is accomplished with minimum loss of time and without sacrifice of valuable space, interference with pro-

duction speed, or the selection of the wrong initial or spare parts through unsystematic storage methods.

In the original plant, water used in testing the boilers under hydrostatic pressure was purchased from the municipality and thrown away after use. The high cost of the water supply justified the construction by the company in its own shops of a 7,000-gallon tank and pipe system by which the water could be used repeatedly, only the leakage and other wastes of the testing bay being made up by the town supply. The new tank was placed below ground to avoid freezing and connected with the hydrostatic-pump equipment in the boiler room; it has proved to be a decided economy over the former plan of using the test water but once. In connection with the testing of the boilers a telephone line was installed between the testing bay and the fire-room, and the control of the pressure at the product greatly facilitated. Instead of trying to vary the pressures by personal trips to and from the fire-room or by a system of bell signals, the test operator instructs the fireman without leaving the testing rack, and time, water, and steam are saved by the immediate response to directions given over the wire. One of the most valuable improvements effected in connection with the testing of the product consists of the simple expedient of attaching an adjustable spring valve and drain pipe to the hydrostatic-pressure supply line running from the boiler room to the testing bay. Just beyond the hydrostatic pump, which supplies the water, a tap to a spring valve is taken off the main line, the discharge side of the valve being connected to a suitable sump. Upon receiving instructions as to the desired test pressure to be maintained, the fireman starts the hydrostatic pump, speeding it up to a point slightly above the limit desired at the testing bay, as shown by an attached gauge. The spring valve is then opened slightly, by-passing enough water to the atmosphere to cause the pressure to fall to the desired amount, and the pressure is then automatically maintained as long as the pump speed is kept at the right point or above the normal by a few per cent. The fireman returns to his regular duty of maintaining normal steam pressure at the boilers, and as long as that pressure is kept constant the pump supplying the testing rack works uniformly. If the pump speeds up slightly, tending to raise the pressure above the setting of the relief valve, the spring of the latter yields sufficiently to permit the discharge of a small quantity of water from the test supply line into the sump, at atmospheric pressure. Thus the pressure on

the boiler under test remains steady so long as the steam pressure in the boiler room holds good; the fireman simply attends to his regular duties and an extra man is not required to handle the pump.

On account of the poor quality of the boiler feed water at the plant it became necessary to introduce a compound just beyond the feed pump. This has been accomplished by installing a small horizontal pump cylinder ½ inch in diameter by 2 inch stroke on the side of the main pump cylinder, and driving it by a hinged lever attached to the rocker arm. A suction pipe ½ inch in diameter was run from the small cylinder into a tank of boiler compound, and a discharge line of the same size connected with the boiler feed pipe. By attaching the hinged lever to the rocker arm the compound is regularly pumped into the feed line, and as the flow of compound corresponds with the speed of the feed pump, the proportion of compound applied remains correct, the device operating automatically without the necessity of attendance.

A short time after the shops were started it was found that much valuable time was lost in the collection of small material used in boiler making, and more systematic methods of storing rivets, bolts, plates, punchings and fittings were sought. Bins were therefore set apart with marked compartments showing the character and size of each part on hand, and in order to facilitate the taking of the annual inventory, the capacity of each bin was translated into weights. The weight of rivets in a full compartment was determined, for example, so that by measuring the height of the material left in the bin at any time the weight on hand could be immediately ascertained. The company adopted the plan of stamping the ends of its boiler plates with the dimensions and quality of each piece, which saved the time required to measure the plates in their selection for the production of each boiler or tank. Thus, a plate of firebox steel marked "171 × 92⅞ × 11/32 F B S," could be picked out easily from odd sizes, avoiding the inconvenience of measuring it in the rack and the possible use of the supply department crane before it could be fitted to the work in hand.

The accumulation of heavy punchings, light iron, and larger pieces of scrap was not well handled at the time the shops were opened for service, and recently the company built a tank for the reception of these rougher and bulkier materials, making the box 16 feet long, 4 feet wide and 5 feet deep, with a sliding door at one end and suitable lugs on the sides and door. By the use of the lugs

the scrap tank can be handled with the utmost facility by the shop crane and the entire contents dumped into a gondola car at minimum expense for handling. Two other labor-saving devices were installed in connection with the handling of tool compound. One was a small tank underneath the tube drills, which was piped to a small belt-driven pump mounted on the machine frame, the pump being operated by the movement of the shafting driving the drills. The compound is now used repeatedly with little waste, being pumped from the receiving tank to the distributing pipe system while the machine is in service. The second improvement consisted of two compound tanks placed 8 feet above the floor and piped to a screened basin below which the supply pails for the various machine tools are filled. The distributing lines from the tanks were valved so that the strength of the compound can be set at any desired point, and much time is saved by this centralization of one of the important auxiliary processes of the plant. Finally, an air whistle was installed at the tool-room distributing window to save waiting for the stock-keeper to observe that a workman desires a tool. Another improvement along the same line was the installation of a bell alarm signal on the telephone of the pattern shop. Plans are now under way to remove the paint and oil-storage department of the plant from the vicinity of the pattern shop, the latter being practically the only department with combustible material stored within its precincts.

EDITORIAL COMMENT

The United States Reclamation Service.

TO all engineers, and especially to those interested in efficiency of administration, we cordially commend a careful reading of an impressive editorial upon the United States Reclamation Service, which appeared in *Engineering News* for January 13.

While the primary question at issue is the conduct of large constructive work under Secretary Ballinger's direction of the Interior Department, there are no politics in the review of the situation as presented. The problem considered is one of engineering as applied to a great national interest, and it is discussed from the standpoint of efficiency in engineering achievement. It is deplorable that the conditions discovered seem to bear a most unfavorable aspect, and to put the Secretary in a position where, in the concluding words of *Engineering News'* editorial, a grave burden rests upon him to "convince the engineering profession of his good faith on the one hand and of his competency on the other."

This regrettable state of affairs in one great department of the United States Government most closely associated with national industries, appears darker yet by a contrast with the excellent model of conscientious and efficient administration supplied by the Navy Department under Secretary Meyer. The Reclamation Service, like the Bureaus of Construction and Steam Engineering in the Navy, involves a sort of work which is easily compared with the successful methods and efficiency standards of private or corporate management. The parallel is closer and more continuous, probably, than in most other government departments. It was by this analogy that we measured the United States Navy organization schemes, put forth in 1909, and found the Newberry projects vicious but the Meyer plans excellent. By even a simpler and plainer application of engineering tests, Secretary Ballinger stands charged with conduct injurious to the public interest. It is a painful duty to arraign an officer so high in the administration, but it *is* a duty, and *Engineering News* has performed it unflinchingly. It is to be hoped that the engineering profession will recognize their duty and their obligation to support the cause so ably put forth, and will give expression to the influence which they can and should exercise in all national questions of this character.

A Practical Shipping Measure.

OF the several measures proposed for the rehabilitation of American shipping the most promising seems to be the admission to American registry of foreign-built ships—at least those engaged in foreign trade. The most ardent protectionist could not reasonably consider it an invasion of the business of American shipyards. Practically nothing for foreign traffic is built there now, and there is no possible hope that it can be. "Protection" has played out the irony of its jest on the American shipbuilder, and has "protected" him out of existence so far as business outside of American waters is concerned. Any measure that

can bring activity to American yards, except incidentally, must go farther and deeper than this. But mere opportunity to purchase shipping advantageously for entry under the American flag may help shipowners and shipmen to a larger place in the affairs of the world, while it affords the country that much desired adjunct to security in peace and in war—a merchant marine.

Graft.

INCOMPETENCE in high places is disastrous, but bad faith is destructive. The curse of American civilization is the tolerance of graft, in multiform guise. The evil is so general that it is regarded with indifference, and accepted as an inevitable part of the natural order to which one must grow callous. The control of political machinery, and to a large extent the conduct of corporate affairs, is seized by and left to the least scrupulous. Men excuse their indifference to politics by pleading the claims of business, and then commit their business interests to a ring of directors who juggle proxies as the boss juggles ballots, and who run the corporation with a sole view to their stock-market operations and contemptuous disregard of their shareholders.

That corrupt lobbies influence legislation, and that directors trade on their foreknowledge and manipulation of company affairs to the detriment of their constituents, though commonly known, awakens no effective expression of public disapproval. "Muckrakers" indeed are plenty; but their influence is a minimum, because too often the reformer is plainly as venal as the offender he denounces, seeking sensation rather than truth and his own gain rather than public righteousness.

Lawmaking is of no effect when the new laws must depend for enforcement upon the same class of officials who have betrayed, for a bribe of whatever sort, their fealty to the old. The more laws ill-administered or evaded, the less respect for all law. It is idle to seek a remedy in legislation until the public conscience is awakened. New standards, not new statutes, are the national need. They are not to be found in the old political parties, which are things of opportunism, pandering to narrow self-interest. But there are yet a goodly company who have not bowed the knee to Baal, and a large proportion of them are to be found in the professions which by training and experience have learned that they must render unfaltering allegiance to the laws of the universe. If the great engineering societies would waken to their possible relations to public policy and public morality, and make common cause for the establishment of tenets as high as those of the Hippocratic oath, what might not be achieved in the removal of the inefficiencies of political and financial corruption! Such a virus would work mightily and beneficently in the body politic; but when will it be applied?

A Correction.

By an error of a sort which would seem to be impossible, but which yet is so common that it has become proverbial with publishers, the figures in Mr. zur Nedden's horse-power calculations on pages 550-552 of our January issue are ten times too large. The demonstration is not in the least affected by the error, as it is wholly proportional, but the absolute figures of power may have startled some readers—as they did the editors and the author when they appeared in the printed pages.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

IRRIGATION IN MESOPOTAMIA.

AN OUTLINE OF THE PROBLEMS AND OF THE PROJECTS SUBMITTED TO THE TURKISH GOVERNMENT BY SIR WILLIAM WILLCOCKS.

Louis Godard—Le Génie Civil.

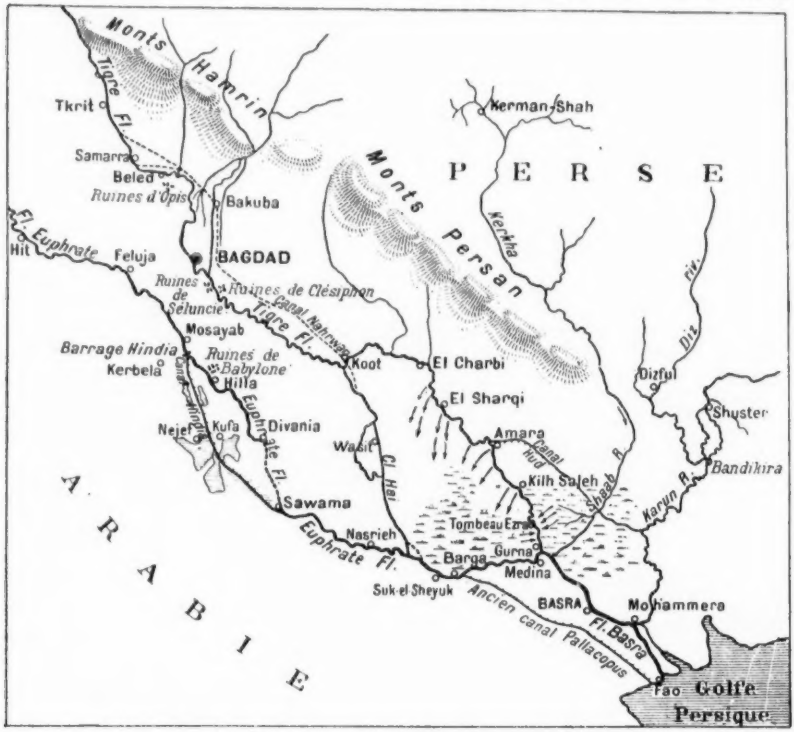
AFTER a visit to Mesopotamia in 1905, Sir William Willcocks published a pamphlet, entitled "The Renaissance of Chaldea," in which he showed the possibility of restoring the barren plains of that part of the Turkish Empire to their former fertility by means of irrigation. The progressive element among Turkish statesmen were not slow to appreciate the importance of Sir William Willcocks' suggestions, and the irrigation of the valleys of the Euphrates and Tigris has been taken up as one of the major projects of the new Government. Sir William Willcocks was retained in 1908 as advisor to the Government on irrigation work and he has already made considerable progress in the formulation of exact plans for the establishment of an irrigation system involving the expenditure of over £7,300,000. An outline of the principal factors comprising the problem of irrigation in Mesopotamia and of the programme submitted to the Turkish Government is taken from an article by Louis Godard in *Le Génie Civil* for October 16, 1909.

The irrigation problems of Mesopotamia differ materially from those of Egypt. The Nile floods last from August to October; in Mesopotamia the Euphrates and Tigris are in flood from March to May, and the period of high water is succeeded by a hot and dry season extending through June, July and August. Irrigation by inundation, such as has been practiced in Egypt since remote antiquity, the regimen of the Euphrates and Tigris makes impossible in Mesopotamia. In fact, the inundation which is of so much benefit to the Nile lands would be a calamity in the delta of the Euphrates, and the works of simple type by which the Nile waters are controlled must be supplemented in Mesopotamia by an elaborate system of irrigation canals.

The total area of Mesopotamia is 5,600,000 hectares (13,840,000 acres), of which 1,300,000 hectares (3,212,000 acres) are available immediately for irrigation, and 2,800,000 hectares (6,919,000 acres) may be made available for agriculture by irrigation after preliminary clearing. Minimum and maximum temperatures at Bagdad, during the ten years 1893 to 1902 were 0.3 degrees C. and 49.1 degrees C. (32.5 degrees F. and 120.4 degrees F.), respectively. In an average year the daily temperature varies from 9.5 degrees C. to 34.8 degrees C. (49 degrees F. to 94.6 degrees F.), with a mean of 23.8 degrees C. (74.8 degrees F.). The monthly rainfall varies from 0 to 46 millimetres (0 to 1.81 inches), with an annual total of 212 millimetres (8.35 inches).

The plains of Mesopotamia are not entirely desert. During the winter

months they are covered with a light vegetation. Sir William Willcocks estimates that during the winter the fields of wheat, barley, etc., will require 25 cubic metres of water per hectare per day (357.3 cubic feet per acre). During the summer the fields of corn will require 70 cubic metres per hectare per day (1,000 cubic feet per acre) and the cotton crops the same amount. Rice fields, during the period of submersion, will require 140 cubic metres per hectare per day (2,000 cubic feet per acre). In the hot summer climate of Mesopotamia crops mature very rapidly.



MAP OF THE DELTA OF THE EUPHRATES AND TIGRIS.

The delta of the Euphrates begins at Hit, 930 kilometres (578 miles) above its mouth in the Persian Gulf. From Hit to Feluja, 130 kilometres (81 miles), the width of the river varies from 250 to 450 metres (820 to 1,480 feet); the valley through which it flows is narrow and subject to inundation. The maximum discharge of this section is 3,500 cubic metres (123,610 cubic feet) per second. From Feluja to Mosayab, 90 kilometres (56 miles), the mean width of the river is 250 metres (820 feet), and the depth varies from 2 metres (6.56 feet) at low water to 5.5 metres (18 feet) at flood. The banks rise about 3 metres (9.85 feet) above low-water mark; hence a flood causing a rise of 3.5 metres (11.5 feet) in the river will inundate the country to a depth of 0.5 metre (1.65 feet). The banks are protected by very feeble dikes. The discharge at Mosayab varies from 300 to 2,500 cubic metres (10,595 to 88,290 cubic feet) per second; the annual mean is about 1,200 cubic metres (42,380 cubic feet).

A little below Mosayab the river divides into two branches, the Hindia Canal on the right and the Hilla branch on the left. The Hilla branch formerly carried the greater part of the water of

the Euphrates, but it has gradually silted up until practically the whole discharge of the river flows through the Hindia Canal. A barrage erected 25 years ago to improve the distribution of water between the two channels has proven ineffective. Sir William Willcocks states that in January, 1905, the head of water stored amounted to 2 metres (6.56 feet), and that the discharge to the Hindia Canal was 750 cubic metres (26,488 cubic feet) per second, while the Hilla branch carried barely 20 cubic metres (706 cubic feet) per second. At high water the storage head is reduced to 1 metre (3.28 feet), and at low water to 1.3 metres (4.26 feet). The Hilla branch is dry 2½ months of the year. The total length of the Hilla branch, from Mosayab to Sawama, where it rejoins the Hindia Canal, is 240 kilometres (149 miles). The size of the channel decreases throughout its entire length, from a width of 150 metres (492 feet) in flood time at its upper end to an insignificant stream at its junction with the Hindia Canal.

From Sawama to Gurna, the confluence of the Euphrates and the Tigris, a distance of 310 kilometres (192 miles), the Euphrates flows through a marshy region, in a shallow channel permitting the navigation of boats drawing not more than 1 metre (3.28 feet). Boats of this draft can be navigated up to the Hindia barrage. Above the Hindia barrage, to Hit, the Euphrates can be navigated at all times by boats drawing 1.25 metres (4.1 feet).

At Beled, 1,010 kilometres (628 miles) above the sea, begins the delta of the Tigris. From Beled to Bagdad (at Elevation + 34), a distance of 110 kilometres (68.4 miles), the width of the river varies from 350 to 4,000 metres (1,148 to 13,120 feet). At Bagdad the discharge varies from 250 to 4,000 cubic metres (8,829 to 141,270 cubic feet) per second, with an annual mean of 1,500 cubic metres (52,970 cubic feet). The Tigris floods occur about a week earlier than those of the Euphrates. The river has been known to rise 4 metres (13.12 feet) in a day. From Bagdad to Koot the width of the river varies from 300 to 400 metres (984 to 1,312 feet), and the mean depth at low water is 1.5 metres (4.92 feet). The banks are about 5.75 metres (18.86 feet) above low-water mark.

Between Koot and Amara, a distance of 260 kilometres (161 miles), the width of the Tigris diminishes from 300 to 200 metres (984 to 656 feet), and the height of the banks above low-water mark from 5 to 1.25 metres (16.4 to 4.1 feet). Between Ali Gharbi and Amara numerous breaches in the banks allow the flood waters to overflow the marshes on the right bank of the Tigris, between the river and the Hai Canal. Just above Amara about half the water required for the irrigation of the eastern region of Mesopotamia flows into the Hud Canal. Between Amara and Gurna, a distance of 140 kilometres (87 miles), the Tigris undergoes great changes. As far down the river as the Tomb of Ezra, numerous breaches in the banks allow the escape of so much water into low watercourses leading into the marshes that the Tigris becomes an insignificant stream, 40 to 50 metres (130 to 165 feet) wide and 1.25 metres (4.1 feet) deep. Sir William Willcocks estimates that of a flood discharge of 2,500 cubic metres (88,290 cubic feet) per second at Amara only 300 cubic metres (10,595 cubic feet) are available at Kihl Saleh. Below the Tomb of Ezra the waters, having traversed the marshes, return clarified to the river bed, and the Tigris enlarges gradually to Gurna, where its width is 125 metres (410 feet), its depth 3 to 4 metres (9.8 to 13.1 feet), and the height of its banks above low water 2.5 metres (8.2 feet). Under existing conditions the Tigris is navigable as far as Bagdad at all seasons by boats drawing not more than 1.25 metres (4.1 feet), but the loss of water between Amara and Gurna is a constant menace to navigation and a serious difficulty in the way of the development of any considerable water traffic.

The other important rivers of Mesopotamia include the Adhem and Dyala, which rise in the Hamrin Mountains and flow into the Tigris, the former 90

kilometres (56 miles) above, and the latter 20 kilometres (12.4 miles) below, Bagdad. The discharges at flood are 250 and 500 cubic metres (8,830 and 17,660 cubic feet) per second, respectively. The River Kerkha flows through the low marshes between the Tigris and the Karun, and discharges partly into the Tigris, partly into the Karun, but principally into the Basra, through the River Shaab, a stream 50 metres (164 feet) wide. The Karun discharges into the Basra, to which it brings more silt than the Euphrates and the Tigris combined. The Basra, known locally as the Shaât-el-Arab, is 160 kilometres (99.4 miles) long, and varies in width, from Gurna to the Persian Gulf, from 300 to 1,000 metres (984 to 3,281 feet). The height of the tide at the mouth is 2.5 metres (8.2 feet) and its effects are felt 50 kilometres (31 miles) up the Euphrates and Tigris above Gurna. Agriculture along the banks of the Basra is sustained by the silt of the Karun, which is carried by the tide as far up the river as Gurna. Over the whole country are found many natural and artificial canals, most of them the remains of old irrigation works, now wholly or partially silted up.

Sir William Willcocks' programme, presented to the Turkish Government on September 21, 1908, provides for works to prevent floods and improve the navigation of the Euphrates and the Tigris, and for an elaborate irrigation scheme to embrace the entire country. The prevention of floods is to be effected by dikes closing the breaches in the banks of both rivers, particularly along the Tigris below Amara. The estimated cost of this part of the programme is £20,000. The projected irrigation works will provide for:

a. The irrigation of the delta between Mosayab and Sawama, along the Hilla branch of the Euphrates, involving the construction of three barrages, one a little above the present Hindia barrage, the others at Hilla and Diwania, for the restoration of the old canals of the region. The estimated cost of this part of the work is £1,500,000.

b. The irrigation of the delta between Feluja-Mosayab on the Euphrates and Bagdad-Seluncie on the Tigris, an area of 250,000 hectares (618,000 acres). The projected works include the construction of a barrage at Feluja and the creation or restoration of irrigation canals, the largest of which will be used for navigation between Feluja and Bagdad. The total cost is estimated at £2,000,000.

c. Irrigation of the delta along the old Hai Canal, which now receives only the high waters of the Tigris. The construction of a barrage at Koot and the creation of a system of canals will assure the irrigation of 300,000 hectares (741,300 acres), at an estimated cost of £1,500,000.

d. Restoration of irrigation in the upper delta of the Tigris, formerly served by two ruined canals controlled by a barrage at Samarra. The area is 180,000 hectares (445,000 acres). The cost is estimated at £2,000,000.

e. Drainage and irrigation of about 70,000 hectares (173,000 acres) of marshy land in the lower delta around Gurna and Basra, at a cost of £300,000.

The works are projected to serve 1,300,000 hectares (3,212,000 acres), and the total cost is estimated at £7,320,000. Sir William Willcocks estimates the annual return at £983,000, of which £650,000 (10s. per hectare) will have to be expended for maintenance.

After a year's study of the problems on the ground, Sir William Willcocks submitted to the Turkish Government on September 1, 1909, revised estimates and specifications for four parts of the work. These included the construction of the new Hindia barrage, locks in both old and new Hindia barrages, and the clearing out of the Hilla branch of the Euphrates, total cost £312,900 (Turkish); a diversion channel to turn part of the flood waters of the Euphrates into a natural reservoir, with regulating works, to cost £199,300 (Turkish); the Feluja barrage with lock and reservoir, £241,600 (Turkish); and the Koot barrage and restoration of the Hai Canal, £640,000 (Turkish).

These estimates call for a total expenditure of £1,394,700 (Turkish). So

far only £224,000 (Turkish) has been appropriated by the Turkish Government, and the work has not been begun. Sir William Willcocks estimated that his whole programme could be carried out in eight years, but at the present rate of appropriation not even the works for which specifications have been prepared could be completed in that time. What arrangements for financing the work may be made in the future, whether it will be carried to completion as a Government undertaking or whether a concession will be made to foreign capitalists, it is impossible to predict with certainty. It is not too much to expect of the Young Turks, however, that some definite plan will soon be adopted and that Sir William Willcocks' projects for the restoration of the "garden of the Orient" will not long fail of accomplishment.

THE WATER SUPPLY FOR THE PANANA CANAL.

AN ESTIMATE OF THE VOLUME OF WATER REQUIRED FOR THE OPERATION OF THE LOCK CANAL NOW UNDER CONSTRUCTION.

Julio F. Sorzano—American Society of Civil Engineers.

COMPUTATIONS of the volume of water required for the operation of the Panama Canal, of the amount of evaporation, percolation, and other losses, and of the quantity of water to be obtained from stream discharge and rainfall during the dry season, lead Mr. Julio F. Sorzano to the startling conclusion that the storage capacity of Gatun Lake is insufficient to provide for the maintenance of the projected 40-foot draft, and will limit the traffic of the canal to less than 20 lockages each way per day. His arguments, given in great detail in a recent paper before the American Society of Civil Engineers, are outlined briefly below.

The adopted plans for the lock canal comprise a high-level waterway between Colon and Panama, consisting of:

a.—One sea-level section, on the Atlantic side, from Colon to Gatun, about 7 miles long.

b.—One set of twin, three-flight locks at Gatun, with a total lift of 88 feet, connecting the sea-level section with the high-level lake at Gatun.

c.—An artificial lake to be formed at a level of 87 feet above the sea, to be used for the storage of water for the locks. In this reservoir, to be named "Gatun Lake," will be dug a channel 45 feet deep and 24 miles long, with submerged banks, for the navigation between the Gatun locks and the Culebra cut. Gatun Lake will have an area of 170 square miles at high water and about 100 square miles at 60 feet elevation.

d.—The high-level canal through Culebra cut, from Gamboa to the Pedro Miguel locks, about 7 miles long.

e.—One set of twin locks at Pedro Miguel, with a lift of 32 feet at high water.

f.—One section of canal, 1 1-3 miles long, between Pedro Miguel and Miraflores, 55 feet above sea level.

g.—A set of twin, two-flight locks at Miraflores on the Pacific slope, with a maximum lift of 66 feet.

h.—A sea-level section from Miraflores to deep water in the Pacific, 8½ miles long.

The twelve locks are to be operated with the water accumulated and stored in the artificial lake from the annual discharge of all the streams emptying into it. The discharge and rainfall are the only sources of water supply for the whole system. It is expected that the depth of water in the lake, under these plans, will vary only from 47 feet at high water to 40 feet at low water, at the end of the dry season.

The commerce of the future will be carried in large vessels of low superstructure, wide beam and extreme draft. Without presuming to predetermine, even approximately, what their dimensions will be, it may be assumed that their draft will be at least equal to that

of the largest vessels now on the ways, say 39 feet 6 inches in salt water, or 40 feet 8 inches in Gatun Lake. Several considerations enter into the determination of the safe clearance for vessels of this draft. Congress has stipulated that 1½ feet must be allowed for the increase in draft in the warm, fresh water of Gatun Lake over the draft in sea water. When protected from the action of winds and waves a vessel can be navigated with a clearance of scarcely 1 foot of water under her keel, but only with the greatest care and at the slowest possible speed. For locks in a canal exposed to wind and wave fluctuations, considerably more clearance is absolutely indispensable, and the designers of the locks have provided for a net clearance of 6 feet over the sills of the twenty-six locks, and of 4 feet over the solid rock bottom of the Culebra cut, where no great fluctuations from waves are to be feared. In Gatun Lake, however, winds and waves may cause such fluctuations of the lake level as may endanger or interrupt navigation. To permit safe and convenient transit through the lock canal, a net clearance of at least 3 feet in the canal proper and of 6 feet in the lake is needed under the keels of passing vessels. Any reduction of such clearances will increase proportionately the risks and dangers of navigation through the submerged channels in Lake Gatun, in some parts of which fogs will frequently occur.

On the Isthmus of Panama the meteorological year can be divided generally into two seasons, the "wet season," lasting from 7 to 9 months, and the "dry season," lasting from 3 to 5 months. On the Atlantic side of the Canal Zone, during the "wet season," the rainfall is always abundant, producing an average annual flow of from 8,000 to 14,000 cubic feet per second for this region; but during the 3 to 5 months of dry weather, the rains cease almost completely, and then the average discharge of all the streams that can empty into the proposed high-level lake at Gatun will rarely exceed 1,100 cubic feet per second in dry years. Records of observations covering a period of more than 20 years give the average annual supply available for Gatun Lake as 8,200 cubic feet per second in dry years, and a dry-season average of 1,200 cubic feet per second for all the region above Gatun. To impound and store, from the surplus of the wet-season discharge, a volume of water sufficient for all the needs of the canal during the ensuing dry period, a lake is to be created at Gatun, with an area of more than 170 square miles, at an elevation of 85 feet above the sea. A fluctuation of 7 feet in the level of that lake would give, during the dry season, an available lake storage of 2 feet above and 5 feet below the normal working level of the locks to be fed by it. On a mean area of 160 square miles, the volume of water thus stored would be 31,223,708,000 cubic feet. This quantity, helped by 1,000 cubic feet per second, the average daily contribution of all the tributary streams discharging into the lake during the dry season, will be the only supply from which the lock canal is to be operated, and is thought, by its designers, to be sufficient for all its needs during the 100 or more days of water scarcity. The Advisory Board of Engineers reported to President Roosevelt in February, 1909: "It is proposed to fill this lake during the rainy season 2 feet above its normal level, and to draw it as needed during the dry season. It is computed, that by drawing it 5 feet below normal level, which draft would leave 40 feet of water through Culebra cut, the supply in a dry year would be sufficient to serve from 30 to 40 lockages up and an equal number of lockages down daily. . . . The water supply in sight is so much greater than any need that can be reasonably anticipated that the best method of securing more water when the time of need arrives does not require to be considered now." Mr. Sorzano believes, however, that under the conditions existing or possible at Panama, the volume of water thus stored will prove to be insufficient for the demands of the canal long before the service reaches the duty specified in the report quoted above.

The water supply must be sufficient to provide for the consumption or loss of water in eleven different manners. We

may summarize Mr. Sorzano's computation of the consumption as follows:

1. *Surface evaporation.* Gatun Lake, with more than 170 square miles of warm, shallow waters, swept by strong and quite constant air currents, will certainly have a very high rate of evaporation. Mr. Sorzano believes that it will be much higher than has been assumed. Taking into account the time during which dense fog may be expected to overhang the lake, he calculates that the evaporation will vary from 0.10 inch in December and May to 0.30 inch in March, with an average of 0.24 to 0.246 for the six months, December to May.

2. *Border evaporation.* The lowering of the level of Lake Gatun, from high to low water according to Mr. Sorzano, in every dry season will uncover an area of land measuring more than 100 square miles. If the border lands, covered with tropical vegetation, are kept moist by capillarity and by the constant fluctuations of the water's edge, border evaporation will reach a considerable amount per day. After due allowance for drainage, run-off, etc., the water evaporated by this daily uncovering of shores and low lands may be estimated at 30 cubic feet per second, and the resultant lowering of the lake level will vary from 0.0066 inch in the first, to 0.0104 inch in the fourth, month of the dry season.

3. *Percolation.* The probable percolation cannot be estimated in advance, even approximately. It can only be guessed at now, and will be ascertained accurately only after the lake is filled. In the absence of experimental data equally applicable to the whole lake basin and taking into account all the elements on which an assumption can properly be based, Mr. Sorzano considers the empirical rule allowing 0.01 inch loss due to seepage per foot of head a prudent one on which to base preliminary computations. This would give, during a dry season, depressions of lake level varving from 0.4750 inch for the first month to 0.3770 inch for the fourth.

4. *Water needed for lockages.* For any given set of conditions the volume of water theoretically required for lockage can be calculated accurately. Mr. Sorzano takes the most favorable set of conditions and assumes a traffic of 20 lockages each way every 24 hours. The lowering of the lake level per day due to loss of lockage water only, he finds, will vary from 0.900 inch for the first, to 1.440 inch for the fourth, month of the dry season.

5. *Normal waste of water during lockages.* In practice the theoretical estimate of the amount of water required for lockages will be considerably exceeded, and what may be termed "normal waste" may cause large losses. If by good management and perfect regulation of the passage of vessels the unavoidable lockage waste is reduced to only 6.66 per cent, it would result in an average daily depression of the lake surface varying from 0.0856 inch for the first month to 0.1370 inch for the fourth.

6. *Water used for hydro-electric plants.* It is intended to generate about 6,000 horse power, part at Gatun and part at Miraflores. The total water required, for net power only and not allowing for waste, will be 1,200 cubic feet per second. The resulting lake depressions will vary from 0.1392 inch for the first month to 0.2227 for the fourth.

7. *Losses due to leakage at gates and valves.* Normal and unavoidable leakage will vary from 8 to 12 per cent of the lockage water under the best conditions of practical equipment. Taking only 8 per cent the daily depressions produced on the lake will be for the first month 0.0684 inch and for the fourth month 0.1095 inch.

8. *Water wasted by maintenance operations.* For the care of the enormous amount of metal work forming the active parts of the locks it will be necessary to empty the locks in many cases. Mr. Sorzano considers 125 cubic feet per second a conservative figure to cover these contingencies. The corresponding depressions in the lake will vary from 0.0290 inch for the first month to 0.0460 inch for the fourth.

9. *Losses due to false manœuvres and accidents.* To cover only normal contingencies Mr. Sorzano allows for losses due to accidents the same amount as for maintenance operations.

10. *Losses at spillways and regulating gates.* Again 125 cubic feet per second is the allowance for spillway losses, the losses, however, extending over only three months.

11. *Miscellaneous losses.* Under this head are included water for domestic and industrial uses, water for passing vessels, and all the losses and wastes at the intermediate section from Pedro Miguel to the sea-level section at Miraflores. For all these losses 300 cubic feet per second is assumed, giving depressions varying from 0.0464 inch for the first month to 0.0742 for the fourth.

Against these losses are to be set the discharge of the tributary streams and the occasional rainfall, amounting, as noted above, to little more than 1,200 cubic feet per second. This amount will add to the lake level 0.3466 inch per day in the first month and 0.4810 inch per day in the fourth. Summing the depressions computed for the eleven sources of loss of water and crediting the lake with the stream discharge and rainfall, Mr. Sorzano gives the net loss by months in inches, for a dry season of four months, as 56.87, 67.05, 72.50, and 73.47 inches, respectively. Hence the total loss of draft in the canal during one dry season will be: after 30 days, 4.74 feet; after 60 days, 10.32 feet; after 90 days, 16.36 feet; after 120 days, 22.48 feet; and after 150 days, 28.61 feet. Using 20 round trips per day as the basis of calculation, the draft of vessels using the canal will be limited after 60 days of dry weather to 33 feet, after 90 days to 28 feet, and after 120 days to 21 feet.

Mr. Sorzano's conclusions are four: that the water supply as planned for the lock canal will be insufficient and inadequate for the most important service for which the canal is being built, the use of the United States Navy; that this insufficiency of water limits for all time the capacity of the lock canal to less than 20 round trips a day; that all the available water supply above Lake Gatun is not sufficient for a larger service, and thus makes impossible any enlargement of the lock canal in the future; and that under the present plans the 40-foot draft expected to be obtained in the canal cannot be maintained. "Unless," he says, "the existing supply of water is augmented by the construction of additional reservoirs and pumping stations, not called for by the present plans, the lock canal cannot be operated on the basis now contemplated."

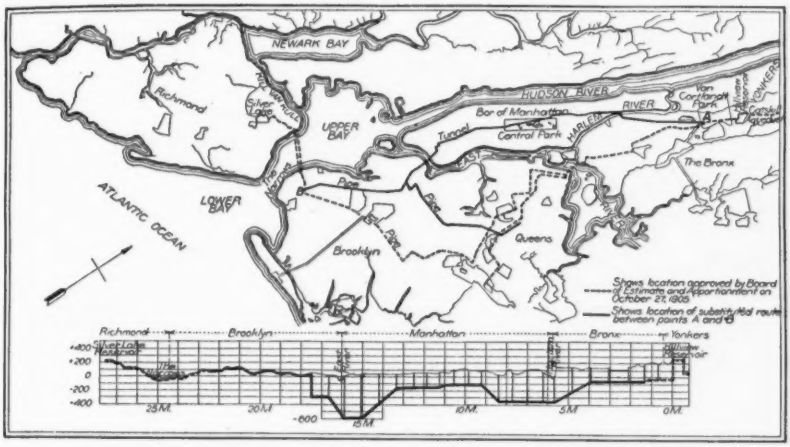
A WATER-SUPPLY TUNNEL FOR NEW YORK.

AN OUTLINE OF THE PROPOSED DELIVERY SYSTEM FOR THE CATSKILL WATER SUPPLY.

Engineering Record.

PLANS for the delivery within the city limits of the Catskill water supply have been submitted by the Board of Water Supply of the City of New York and are now under consideration by the Board of Estimate and Apportionment. The portion of the Catskill system covered by the proposed plans includes all lines south of the Hill View reservoir, an equalizing basin near Yonkers, N. Y., from which it is proposed to deliver among the five boroughs of the city, through 17½ miles of deep-pressure tunnel, and 16 miles of pipe line, 520,000,000 gallons of water per day. Of this quantity Brooklyn will require 100,000,000 gallons, and Richmond, 20,000,000 gallons, leaving 400,000,000 gallons for Manhattan, the Bronx and Queens. From *Engineering Record* for December 11, 1909, we take a few details of the proposed system.

"The system recommended consists of a pressure tunnel, varying in diameter from 16½ to 11 feet, driven deep in the ledge rock, from the Hill View reservoir, beneath the Borough of the Bronx, Harlem River, Manhattan Island, East River into Brooklyn, terminating at a point near the Atlantic Avenue Station of the Long Island Railroad, about one mile east of the East River; from this point pipe lines will extend south under The Narrows to a terminal reservoir, El.



PLAN AND ELEVATION OF THE PROPOSED DELIVERY SYSTEM.

225, at Silver Lake on the north end of Staten Island, or the Borough of Richmond, and northeast into the Borough of Queens.

"At the Hill View reservoir, where the flow line is at El. 295, a downtake shaft, some 300 feet deep, will be sunk and from its bottom the pressure tunnel will be driven south, following the tentative lines and grades indicated on the accompanying plan and profile.

"The special feature of this system is the rock tunnel which will pass through the gneiss, schist and limestone formations underlying New York City, only a small percentage of the tunnel being in the limestone, this rock being cut at right angles by the line to minimize the length of tunnel in this formation. The amount of water to be provided for is unusually large and to insure permanence in the completed structure advantage was taken of the existence of sound rock under the city in fixing the lines and grades. Twenty-three construction shafts will divide the 17½ miles of tunnel into sections averaging about 4,000 feet in length, and each construction shaft will be utilized upon completion as an uptake shaft with connections to the distribution pipe system. These uptakes and connections are to be guarded by special valves, and it will be possible to take from any connection a quantity of water to meet unexpected demands of consumption in other districts due to unlooked-for developments.

"In the plans for prosecuting the tunnel work it is proposed to locate all construction shafts in parks or at other places where the handling of materials through the shafts will not obstruct street traffic. The large trunk delivery conduit possesses a number of advantages over a system composed entirely of pipes. The tunnel is to be lined with concrete, made as impervious as possible, but dependence is placed to a considerable degree upon the rock cover which will usually be at least 150 to 200 feet of sound rock for the necessary strength and water tightness.

"The tunnel will have a capacity equivalent to thirty 48-inch pipes, and among its advantages are: Construction cost of about 50 per cent of that for a pipe-line system consisting of 48-inch cast-iron mains; annual charges for interest, sinking fund and maintenance of less than 50 per cent of that required for pipe lines; non-interference with existing subsurface structures, such as subways and sewers; elimination of opening of streets during construction and for subsequent repairs and renewals; elimination of possibility of failure by breakage, except at uptakes, where special precautions can be taken to guard against failure; proportional increased capacity for emergencies to control large fires; cross con-

nection of the existing water-supply systems of all boroughs with an artery of sufficient size to be used in emergency to temporarily replace any of the present water-supply systems.

"By delivering the water through the system proposed now, instead of entirely through pipe lines, as suggested in the 1905 report, an additional pressure of 100 feet is gained in the lower part of Manhattan and in Brooklyn and Richmond, so that water can be delivered in Brooklyn at an elevation approximately 260 feet and in Richmond at an elevation 225 feet above sea level. This makes possible the elimination of much of the present public and private pumping necessitated by the low level at which the Croton and Ridgewood supplies are delivered.

"The method of construction of the tunnel from Hill View reservoir to Brooklyn would be in all respects like that already in execution under the Rondout, Wallkill and Moodna valleys, west of the Hudson River, and beneath Croton Lake on the east side of the river; it is also the type proposed for the Hudson River crossing.

"Extensive borings have been made throughout the length of this line, and other borings are in progress to determine details of geology at a number of less well-known points. The line is said to have been sufficiently well explored to determine the feasibility of the project, and the additional boring is for the purpose of determining construction details. Every advantage also has been taken of a great deal of information previously obtained regarding sub-surface conditions. The capacity of the present distribution pipe system will be greatly increased by virtue of the frequent points of connection with the tunnel, through which large quantities can be delivered into the pipes. The present scheme eliminates Forest Park reservoir, in Queens borough, which was proposed in 1905, thus saving several millions of dollars. The work on the tunnel and pipe lines can be attacked at many points and pushed forward rapidly. By laying the pipe across The Narrows immediately, relief can be afforded the Borough of Richmond before the Catskill water is available by taking a few million gallons a day from the Ridgewood system of Brooklyn. By constructing at once a tunnel from lower Manhattan under the East River to Brooklyn, Brooklyn can share with Manhattan in the use of the Croton supply, if that should become necessary during the few years that will intervene before Catskill water reaches the city."

THE APPLICATION OF MOTORS TO MACHINE TOOLS.

A SUMMARY OF STANDARD PRACTICE IN THE SELECTION AND APPLICATION OF THE MOTORS FOR DRIVING MACHINES OF VARIOUS CLASSES.

A. L. De Leeuw—American Society of Mechanical Engineers.

A LONG and comprehensive paper on the economy of the electric drive in the machine shop, read by A. L. De Leeuw before the American Society of Mechanical Engineers at the recent annual meeting, concludes with a summary of standard practice in the selection of motors for driving machine tools of various classes, the mode of application of the motors to the tools, and the lines along which economical results may be expected from the installation of the electric drive. The greater part of Mr. De Leeuw's admirable paper deals with features of the subject which have been discussed already in more or less detail in the pages of THE ENGINEERING MAGAZINE, and the extracts following are confined to his outline of standardized practice so far as it is at present defined.

"*Bench lathes.* To be driven from a countershaft, attached to the wall or bench and driven in its turn by a motor. Any kind of motor, except a series-wound or heavily compounded motor will do. The object of the motor drive is to get the machine in the best possible lo-

cation without regard to the location of the line shafting. A number of these machines may be driven by a common line shaft, driven by a motor.

"*Speed lathes.* To be driven from a countershaft, located under the lathe, or by a direct-connected motor. In the latter case, a variable speed motor is to be preferred, if direct current is available. Motor drive is recommended when the machine is used in the assembling department as the machine may then be placed where it is most needed, and the assembling department being generally of greater height than other departments, crane service would interfere with countershafts. There will be no material gain if the machine is to be used for ordinary shop operations.

"*Engine lathes.* Various modes of motor driving are in use. Some makers furnish motor-driven engine lathes as standard apparatus. Some have a headstock with a limited number of speeds and depend on a variable speed motor to fill out the speeds of the lathe. Others apply a constant-speed motor, or one with a limited amount of variation, to an all-geared headstock. In general, the use of this class of machines in the shop would naturally lead to group drive. Advantages of the individual motor drive lie in the possibility of completing a job in one setting. There is no material advantage if the machines are used for regular manufacturing operations, except where the location demands the motor drive.

"*Heavy engine lathes, forge lathes, etc.* To be driven by a direct-connected motor. The motor should be direct current, as these machines are too heavy to permit a convenient all-gear drive. If no direct current is available and there is only one machine of its class in the shop, and this is used for an occasional job only, an alternating-current motor could be used, leaving a wide gap in the speeds. If these machines are used for manufacturing purposes, however, it will pay to instal a small synchronous converter. The speed range in the motor does not need to exceed two to one, though a wider range is better if obtainable without complications or large expenses. The position of the motor should be low, as the vibrations in the motor support have a decided influence on the capacity of the machine, as well as on the repair bill. The output of this class of machine may easily be increased from 20 per cent to 25 per cent by motor drive.

"Further advantages of the motor drive are the possibility of placing the machine in the line of routing of heavy work, and of placing it immediately under the traveling crane. The latter object may be reached with a belt-driven machine by placing the headstock under the gallery, if the construction of the shop lends itself to this arrangement, but the same convenience as that of the motor drive cannot be obtained.

"*Axle lathes, wheel lathes, and driving-wheel lathes.* It is of the greatest importance that this class of machinery should have the highest possible efficiency and the most convenient location. These machines are mostly used in railroad repair shops, where time saved does not mean merely the saving of some wages, but each day gained means an added day in the earning capacity of the engine. It is, therefore, important that these machines be motor driven whenever installed in a railroad repair shop, though this does not mean that they should not be so driven if used for manufacturing. Direct current should be used. The economy of the motor drive should not be figured in increased output, but in reduction in time required to repair an engine.

"*Chucking lathes.* Generally speaking, there is little reason why a chucking lathe should be motor driven. Most chucking lathes are provided with the necessary mechanism to shift speeds quickly. A few types handling large work may be motor driven to advantage, though practically the only advantage lies in the fact that small gradations can be thus obtained Such machines require, therefore, a variable-speed motor.

"*Automatic screw machines.* Small machines of this class are generally group driven. Large machines may be motor driven to good advantage. The larger sizes have generally one or two

speeds for one piece of work, though these speeds may be varied when the machine is reset for a new piece of work. The speed given to the machine must naturally be proportional to the largest diameter to be turned, or in other words, to the size of the stock used. This will reduce the speed for some of the operations, such as drilling and reaming, far below the economical speed. The amount of time saved by the application of the variable-speed motor may be considerable. Where the construction of the machine permits, two motors, one for feed and one for speed, would give still better results. In all cases variable-speed motors should be used.

"*Drill presses.* The only reason why a sensitive drill should be individually motor driven is that it is often used in an assembling department, where height of ceiling and crane service would make a belt drive awkward or impossible. Most sensitive drills have in themselves all the speeds required for their work, so that any type of motor will be adaptable. The motor may either be directly applied to the machine or may drive a countershaft on a stand, or be placed on the floor by the side of the machine in case the machine carries its own set of cones or other variable-speed device.

"Generally speaking, the upright drill is used for manufacturing operations and does not require frequent changes of speed. There are, however, many exceptions, for instance where upright drills are used to do all the operations on a piece by means of a jig. In this case frequent changes of tools, and therefore of speeds, are required, and an individual motor drive, whether direct connected to the machine or operating on the countershaft, is of the greatest benefit. No great benefit can be derived from a constant-speed motor with this type of machine. Radial drills may be considered the same as upright drills. There is an additional reason why radial drills should be motor driven—they are often used in the neighborhood of the assembling floor.

"*Boring machines.* When boring machines are specialized, performing only one operation, there is no good reason why the motor drive should be preferred to belt drives. Where, however, the machine is used for a multiplicity of operations, such as drilling, boring, reaming and facing, a motor drive is beneficial if a variable-speed motor is used. The range of speed of the motor should be as wide as possible that no gears may have to be shifted for the entire set of operations on a single hole. Especially where a boring machine is used for facing, this variable speed will be found highly economical.

"*Grinders.* Grinders in general require so many various movements driven from countershafts that it is hardly possible to apply a single motor directly to the machine. The best that can be done is to attach the countershaft to the machine and drive the former from a motor standing on the floor or on a bracket attached to the machine. In isolated cases it would be well to have one or more motors, each controlling a single operation, attached directly to the machine.

"*Planers.* Planers in general are not benefited by the application of a motor, as the motor only complicates the difficulties of a planer drive. However, large planers which must be placed under a crane give better results when motor driven on account of the facility of handling the work. Another possible advantage when using a variable-speed motor and controlling the speed of the motor at the end of the stroke is that much higher return speeds can be obtained in connection with any desired cutting speed.

"*Shapers, slotters, etc.* What is true of planers is true also of these classes of machines. Local conditions may make it advisable to drive them individually by motor, but generally speaking there is no great benefit with this drive.

"*Milling machines.* The larger sizes of knee-and-column type machines, if motor driven, will give the best results if the motor is of the variable-speed type, especially where these machines are used for gang work. This is due to the fact that the speed of the mills is dependent on the smallest cutter, not count-

ing the limitations due to the nature of the work. It is therefore important that the speed should be as close to the permissible limit as possible. When applied to this type of milling machine the motor should be as low down as possible, as vibrations in the machine have a marked effect on the quality of the finish.

"Planer-type milling machines. In practically all cases this type of machine should be motor driven in order that they may be located under a crane. It is not so very material, however, whether the motor is of the constant-speed or variable-speed type.

"Punches, bending rolls, shears, etc. This class of machinery, used largely for boiler, bridge, structural iron and shipbuilding work, is generally placed in high shops and under cranes, and in locations and directions most convenient for the routing of the work. The shops in which they are placed are generally large and contain a relatively small amount of machinery, so that the amount of transmission gearing required is large in proportion to the amount of machinery. It is for this reason advisable in almost all cases to drive this class of machinery by a motor, which, of course, does not need to be of the variable-speed type."

TRIALS OF THE MELVILLE-MACALPINE SPEED-REDUCTION GEAR.

A REPORT OF TESTS OF THE DOUBLE-HELICAL SPUR GEAR FOR REDUCING THE SPEED OF MARINE TURBINES.

Engineering News.

A UNIT of the Melville-Macalpine speed reduction gear for application to marine turbines, which was described at length in these columns in THE ENGINEERING MAGAZINE for November, 1909, designed to transmit 6,000 horse power, has been under test for some weeks at the works of the Westinghouse Machine Company, of East Pittsburg, Pa. The results, which are made public in *Engineering News* for December 30, 1909, show a remarkable efficiency, exceeding by over 3 per cent. the most sanguine expectations of the inventors. We supplement the information given in our previous review with a brief statement of the efficiencies obtained over a wide range of powers transmitted.

"The first trials of the gear were made at very moderate speeds and loads, with frequent stops to examine the condition of the teeth and bearings. During the first few days the speed was gradually raised to 1,500 revolutions per minute of the turbine shaft (equivalent to a speed of 5,500 feet per minute on the pitch circle) and 300 revolutions of the gear shaft, and a load of over 6,000 brake horse power was carried. The load was limited only by the power of the turbine, as there were no indications that the ultimate safe capacity of the gear had from any standpoint been nearly approached."

On Saturday, October 16, 1909, an endurance test at maximum load and speed was begun at 3.15 p. m. and continued for 40 hours. The load was applied by a specially designed hydraulic dynamometer. During the trial the average speed was 300.6 revolutions per minute, and the average brake horse power recorded was 6,048. There was nothing in the operation of the gear to indicate that this load might not be carried indefinitely, but the test was suspended at 7.15 a. m. Monday morning, on account of the inability of the power plant to stand so large a draft without interference with the regular operation of the works. No useful data, however, could have been obtained from a further prolongation of the trial, excepting the very probable development that as the wearing parts became polished and took on a better surface, the operation of the apparatus would improve. The trial continued over 34 hours after the temperature conditions had become constant.

The turbine used in the test was carefully calibrated at 1,500 revolutions per minute with a vacuum of 22.78 inches,

corrected to a barometric pressure of 30 inches. At every load, therefore, before reading the inlet pressure, the speed of the turbine was brought exactly to 1,500 revolutions, as indicated by a vibration tachometer, and the vacuum adjusted to exactly 22.78 inches. The results of a series of readings were as follows:

Inlet pressure absolute.	B. H. P. delivered by gear.	B. H.P. of turbine from calibration curve.	Efficiency.
111.8	3,712	3,771	98.7
122.3	4,156	4,197	99.0
132.3	4,576	4,623	98.9
142.3	5,036	5,108	98.7
152.3	5,486	5,567	98.5
162.3	5,927	6,057	98.7

A check on these figures of efficiency was obtained by calculating the heat loss in friction from the quantity of oil circulated through the gear and the rise in the temperature of the oil. Giving due weight to both methods of measurement, and considering the closeness of agreement between them, it is quite evident that at approximately 5,000 horse power, with the turbine running at 1,500 revolutions per minute and the driven shaft at 300 revolutions per minute, the efficiency of the gear is more than 98.5 per cent. Less elaborate and extensive determinations show an efficiency of 98 per cent. at a load of 3,000 horse power and 1,000 revolutions of the turbine, and 95 per cent. at a load of only 824 horse power and 750 revolutions of the turbine.

TURBINES IN THE UNITED STATES NAVY.

THE COMPARATIVE RADIUS OF ACTION OF TURBINE AND RECIPROCATING-ENGINE VESSELS AS INDICATED IN TRIALS OF RECENT BATTLESHIPS.

The Engineer.

THE official results of the steam trials of the two latest additions to the United States Navy, the *Delaware* and the *North Dakota*, are commented upon in *The Engineer* for December 17, 1909, in a lengthy editorial which we reprint in full below. The similarity of the two vessels in every essential particular except propelling machinery offers an opportunity for comparison of the radius of action of turbine and reciprocating-engine warships such as can seldom be had, and it is to this aspect of the results that *The Engineer* directs special attention.

"It is impossible to over-estimate the naval importance of an experiment which has been very recently carried out by the United States Government. It is a matter of almost common knowledge that the efficiency of a warship depends largely on her range of action. In other words, how far she can go without having to refill her bunkers. This depends on certain factors, which are all variables. Thus, let us suppose that the consumption of fuel varies as the square of the speed. Then doubling the speed augments the consumption per hour or per day fourfold; but for any given distance the consumption is only doubled because the number of days or hours of steaming is halved. In practice, of course, for the higher velocities the consumption per hour augments in a much more rapid ratio. But the augmentation is not a fixed quantity. Every ship has a different rate. Again, we have the consumption of fuel varying with the power, because some powers are more economical than others. The general result may be summed up in a few words. For every ship there is a speed at which she can steam further per ton of coal burned than she can steam at any other speed. What this speed may be can only be determined by direct experiment. It is clear, however, that, particularly in the case of warships, the higher the velocity the better. So much premised, we may proceed to the experiment.

"Two of the most recent additions to the United States Navy are two Dreadnoughts. These are the *Delaware* and the *North Dakota*. It is claimed for them that they are the most powerful warships afloat. They are in all respects but their machinery sisters. Each can fire a broadside from ten 12-inch and seven rapid-fire 5-inch guns. Their dis-

RESULTS OF THE STEAMING TRIALS OF THE *Delaware* AND *North Dakota*.

Delaware.

Water per indicated horse-power per hour, main engines only....	12 knots, 15.48 lb.	19 knots, 12.7 lb.	21 knots, 12.9 lb.
Water per indicated horse-power per hour, all purposes.....	12.24 knots, 21.03 lb.	19.225 knots, 14.52 lb.	21.563 knots, 14.8 lb.
Total water per hour, all purposes	12.24 knots, 83,463 lb.	19.225 knots, 250,549 lb.	21.563 knots, 422,931 lb.
Total water per hour for main engines only	12 knots, 55,000 lb.	19 knots, 205,000 lb.	21 knots, 312,000 lb.

North Dakota.

Water per shaft horse-power per hour, main turbines only.....	12 knots, 20.6 lb.	19 knots, 14.25 lb.	21 knots, 13.8 lb.
Water per shaft horse-power per hour, main turbines and engines' auxiliaries .....12.1 knots, 23.94 lb.		19.245 knots, 15.92 lb.	21.64 knots, 14.408 lb.
Total water per hour, main turbines and engines' auxiliaries...	12.066 knots, 90,981 lb.	19.245 knots, 266,761.1 lb.	21.64 knots, 450,965 lb.
Total water per hour for main turbines only	12 knots, 76,000 lb.	19 knots, 238,000 lb.	21 knots, 349,000 lb.

placement is about 21,500 tons, and their nominal or contract speed 21 knots, a velocity which has been considerably exceeded by both ships. The *North Dakota* was built and engined by the Fore River Shipbuilding Company, and is propelled by Curtis turbines, developing on the high-speed trials 31,400 shaft horse power, which drove her at 22.25 knots. The *Delaware* was built and engined by the Newport News Shipbuilding Company. She has reciprocating engines, and on her trial attained a speed of 21.563 knots with 28,578 indicated horse power. Not only were trials made to settle speeds and powers, but also incidentally to fix the range of action of the two great ships. A keen controversy is going on between the two shipbuilding companies to settle this point. Above will be found a table containing the official figures, and we are told that the United States Bureau of Steam Engineering estimate that the *North Dakota* can steam about 5,000 knots, and the *Delaware* 6,000 knots, without quite emptying their bunkers—figures which do not appear justified by those above.

"We now proceed to examine the facts in a little more detail; and, first, as to the consumption of fuel. Taking the main engines only, we find that at 12 knots, 19 knots and 21 knots, the *Delaware* required 15.48 pounds, 12.7 pounds and 12.9 pounds of feed water per horse power per hour. The *North Dakota*, at the same speed, required per shaft horse power 20.6 pounds, 14.25 pounds and 13.8 pounds. Even after we have made an allowance for the difference between shaft and indicated horse power, we find that the Curtis turbine is not so economical as the piston engine, and as was to be expected, this is particularly manifest for the lower powers. Every steam engine, whether it is a piston engine or a turbine, has a certain speed which is more economical than any other speed. In the *Delaware* the difference between best and worst is only 2.58 pounds; in the *North Dakota* it is 6.8 pounds, or nearly three times as much. The *Delaware*, during a full-speed four hours' trial run on the 23d of October, made 21.563 knots with 28,578 indicated horse power and a coal consumption of 24 English tons per hour. The figures for the *North Dakota* have not reached us, but we deduce them from the published water consumption. At 21.64 knots she burned 28 tons per hour; taking the fraction of a knot higher speed into account, it may be said that the consumption—which is in American tons of 2,000 pounds—was about the same for both ships. This is assuming that the boilers evaporated 8 pounds of water per pound of coal, which is the stated evaporation. Applying the same rule to the *Delaware*, we find that the consumption was 26½ tons per hour. We may take it that at these high velocities there was no substantial difference between the ships.

"Turning now to the lower speeds, we find, calculating in the same way, that at 12.24 knots the *Delaware* burned 5.26 tons per hour, and the *North Dakota*, at 12.06 knots, 5.6 tons. The builders of the *Delaware* give the consumption a 4.3 tons per hour at 12 knots. The Fore River Company do not give any figures. If the builders of the *Delaware* are right, then the boilers must evaporate more than 8 pounds per pound of coal. The

Delaware made, we are told, 21 knots with 23,600 horse power, 19 knots with 14,560, and 12 knots with 3,520 indicated horse power. It will be seen from the table that at all these speeds the total weight of steam used by the *North Dakota*, including all auxiliaries, was in excess of that required by the *Delaware*. The data are, however, incomplete, in that nothing has been said—officially at all events—about the comparative efficiency of the propellers in the two ships. The probability, nay, the certainty, is that the propellers of the *Delaware* are more efficient than those of the *North Dakota*. But it is not necessary to go far into this question. We have only a certain number of facts to go upon, and these show that so far as range of activity is concerned, the turbine is, other things being equal, inferior to the piston engine. The highest average speed attained by the *Delaware* was 21.563 knots, and that, as we have said, was got with 28,600 indicated horse power. The highest speed obtained with the sister ship was 21.64 knots—a scarcely appreciable difference, while the shaft power was 31,400, a difference of not less than 9 per cent. If we deduct 10 per cent. from the indicated horse power of the *Delaware* engines we have 25,740 as the shaft horse power, or but 82 per cent. of that of the *North Dakota*. These figures, inconclusive as they are, go to show that the propellers of the turbine ship must be much less efficient than those of the *Delaware*. This handicaps the turbine. But the turbine and the propeller are inseparable. They work together, and the naval architect must deal with them as a whole. The result of the experiment seems to be so far adverse to the turbine. But the end is not yet. The last word has not been said concerning either turbines or propellers."

BRIQUETTED COAL IN LOCOMOTIVE AND MARINE BOILERS.

REPORTS OF COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL IN LOCOMOTIVE AND TORPEDO-BOAT BOILERS.

W. T. Ray and H. Kreisinger—United States Geological Survey.

WE have already given in these columns* some details of the results of the extended investigations conducted by the Technologic Branch of the United States Geological Survey on the furnace behavior and evaporative efficiency in locomotive boilers of briquetted coals, compared with the same coals in the raw state. The tests to which our previous review referred were carried out at the locomotive plant of the Pennsylvania Railroad at Altoona on a simple Atlantic-type passenger locomotive, class E2a. Subsequent tests on a locomotive of the Seaboard Air Line, undertaken to add cumulative evidence to these earlier results, have recently been concluded at Portsmouth, Va., and form the subject of Bulletin 412 of the Survey publications. This Bulletin appears coincidently with Bulletin 403, describing comparative tests of run-of-mine and briquetted coal on the torpedo boat *Biddle*, and we give below a brief abstract of the two reports.

In the locomotive tests comparative steaming trials were made with run-of-mine coal and the same coal formed into briquettes of two sizes. The primary object of the tests was to study the relative performances of the two types of briquettes and of the coal, with reference to efficiency, tendency to smoke, and the ease with which steam could be kept up, when each of the three varieties of fuel was burned at several rates of combustion. One object kept especially in mind was the finding of ways of working locomotive boilers harder.

The smaller of the two sizes of briquettes was circular in horizontal cross section, 3¼ inches in diameter. Its vertical cross section was nearly oval, 2¾ inches at the center by 1¼ inches near the circumference. The larger size was rectangular in either cross section, its

*THE ENGINEERING MAGAZINE, April, 1909.

dimensions being 3 by 4¼ by 6¾ inches. The small briquettes were compressed at about 1,000 pounds, and the large ones at about 2,500 pounds, per square inch. The pitch used was approximately the same in kind and percentage.

The locomotive used was of the 10-wheel freight type, built in 1906. The furnace was 108 inches long, 41 to 55 inches wide, and 55 inches high. The rocker, finger-type grate was 104 inches long and had an area of 29.65 square feet, the air space being approximately 30 per cent. The ratio of grate area to heating surface was 1 to 87.2. The boiler had 328 tubes, 2 inches in inside diameter and 14 feet 2 inches long. The total heating surface of firebox and tubes was 2,584 square feet.

In all, 14 tests were made, 6 on run-of-mine coal, 4 on large briquettes and 4 on small briquettes, the locomotive remaining stationary in all the trials. The tests were made at various rates of combustion, the lowest being 18 pounds of dry fuel per hour per square foot of grate surface when burning coal, and the highest being about 110 pounds of dry fuel when burning small briquettes. The results are presented in a series of tables and curves. Briefly stated, the general deductions are as follows:

1. At low rates of working, run-of-mine coal gives a higher equivalent evaporation than briquettes; at medium rates there is little difference; at high rates briquettes do considerably better. At the usual rate of combustion in locomotives the equivalent evaporation with either kind of briquette is 10 to 15 per cent higher than with run-of-mine coal.

2. So far as blackness of smoke is concerned there seems to be little advantage in briquettes over run-of-mine coal. However, the loss in sparks is less, and especially with the larger size of briquettes.

3. There is little difference between the large and the small briquettes; the larger ones crumble less. The smaller briquettes are easier to fire and to level on the fire than are the larger ones; either form gives the fireman far less work and trouble than run-of-mine coal. It is a great deal easier to raise and keep up steam with briquettes than with run-of-mine coal. Higher rates of combustion are feasible, and consequently higher power, which is of especially great advantage on long grades. On roads having heavy grades it will probably pay well to burn briquettes, at least part of the time. Inasmuch as locomotives are already worked at high rates of combustion, and as higher and higher rates will be desired, the use of briquettes has a rather promising future in steam-locomotive service.

The trials on the torpedo boat *Biddle* were all made with the boat moored at a dock, time and men not being available for carrying out projected steaming tests at sea. The main object of the tests was to determine whether the use of briquetted coal on torpedo boats has any advantages over the use of raw coal. Besides comparing the economy obtained with briquetted and raw coal, the following properties of the two fuels were given particular attention: (*a*) the tendency to smoke; (*b*) the amount of sparks emitted from the stack; (*c*) the rate at which steam can be made and the ease with which the fires are handled; (*d*) the ease of transferring fuel from the coal bunkers into the fireroom. The coal used came from four different mines in the New River field of West Virginia. The briquettes were of two sizes, similar to those used in the locomotive tests described above.

The torpedo boat *Biddle* is 157 feet in length on load water line, 17 feet 7½ inches extreme beam, and 175 tons displacement. Its equipment includes two triple-expansion engines and two exactly similar water-tube boilers. The engines are in separate compartments amidships. The boilers are in separate boiler rooms, one at each end of the engine compartments, the fronts of the boilers facing the latter. In front of each boiler is a space about 10 feet square used as the fireroom, in which is placed an auxiliary feed pump and the wheel of a blower fan. Only the forward boiler was used for tests. It is of the curved water-tube type known as the Normand boiler, consisting essentially of a steam drum connected to two mud

drums by 1,552 tubes 1 3-16 inches in external diameter and two 10¾-inch downcomers in the rear of the boiler. The furnace is placed under the steam drum between the two nests of water tubes and the mud drums. It is equipped with a plain grate for hand firing, 58.6 square feet in area. The total heating surface is 2,776.19 square feet.

In making the tests steam was generated at 200 pounds pressure and discharged into the atmosphere. In all 21 tests were made, 10 with run-of-mine coal, 3 with large briquettes and 8 with small briquettes, varying the rate of combustion from 20 to 60 pounds of coal per square foot of grate area per hour. The results are given in a series of tables and curves, from which the general deductions may be summarized as follows:

1. There is little or no gain in efficiency in burning briquettes of either size. The run-of-mine coal does as well as the small briquettes and perhaps better than the larger ones. To the question why the use of briquettes in marine boilers does not result in an improvement in boiler economy similar to that found in stationary and locomotive practice no definite answer can be given at present.

2. Both large and small briquettes make as much smoke as, or more than, run-of-mine coal. There seems to be more flaming in the stack with briquettes than with run-of-mine coal. About the same amount of sparks are emitted from the stack with the two fuels.

3. A somewhat higher boiler capacity can be obtained with briquettes than with run-of-mine coal and steam can be raised more quickly with the former.

4. When burning briquettes the fire does not need to be disturbed; with coal the fuel bed has to be broken up, generally after each firing. Run-of-mine coal is transferred much more readily than briquettes from the coal bunker to the fireroom. With briquettes the capacity of the coal bunker is reduced by 23 to 25 per cent.

PIPE FITTINGS FOR USE WITH SUPERHEATED STEAM.

A SYMPOSIUM OF PAPERS ON THE EFFECT OF SUPERHEATED STEAM ON CAST IRON AND STEEL.

I. N. Hollis, E. F. Miller, A. S. Mann—American Society of Mechanical Engineers.

FAILURES of cast-iron fittings in superheated-steam piping systems have occurred with sufficient frequency to create a widespread suspicion of this material when exposed to high temperatures and pressures. Yet there is little information available of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast-iron fittings. Steel castings have given fair, and even complete, success in many cases, but failures of steel valves and fittings are by no means unknown. Cast iron has been used for many years at all degrees of temperature below actual redness with complete success, and in many plants using moderate degrees of superheat cast-iron fittings have never given the slightest trouble beyond the ordinary wear and tear. Opinion on the subject is very diverse and exact information remarkably difficult to obtain.

A symposium of three papers read at a recent meeting of the Boston Section of the American Society of Mechanical Engineers and published in the *Journal* for December, 1909, reviews the established facts concerning the effect of superheated steam on cast iron and steel and offers a few data on which a selection of material for pipe fittings may be based. The first of these, by Prof. Ira N. Hollis, gives the results of some strength tests of cast-iron fittings after use with superheated steam. Outlining the known facts concerning the effects of high temperature and pressure on cast iron, Prof. Hollis points out that the doubt as to the reliability of cast iron has seemed to spring up with its use in long pipe lines to steam tur-

bines, where the temperature has ranged from 550 to 600 degrees. This would lead one to ask if the difficulty has not been in the design of the piping systems rather than in the character of the material. All that can be claimed against cast iron beyond the possibility of controversy is that fittings have developed cracks and small changes of shape after a few months of actual service; that fittings exposed separately to superheated steam at a temperature exceeding 500 degrees F. have shown a permanent increase of some dimensions; and that tensile tests of pieces cut from fittings that had failed in service indicate in some cases the possibility of permanent loss of strength. Has not cast iron taken the brunt of a new service and suffered in reputation because the conditions have not been fully understood?

Prof. Hollis does not attempt a complete reply to this question but offers the results of some tests made for the Edison Illuminating Company, of Boston, to determine the bursting strength under hydraulic pressure of some large cast-iron fittings that were replaced by steel castings, as throwing some light on the subject. The fittings were taken from a main steam line, over 103 feet long, without expansion or slip joints, anchored at the turbine end and allowed to expand freely in a longitudinal direction carrying with it the lower ends of four vertical steam mains leading from the boilers. The steam pressure is 175 pounds and the superheating generally amounts to 150 degrees F. The actual temperature of the steam varies from 500 to 580 degrees, so that the main line is changing in length from time to time and introducing a series of variable stresses into all parts of the pipe system, which affect most seriously the tees. It is this aspect of the question, the effect of variable stresses on cast iron at high temperature, which requires most serious consideration.

Prof. Hollis' tests included tensile tests of test pieces cut from various parts of fittings which showed signs of failure in service, and bursting tests on two apparently sound used tees and an unused elbow. Without detailing the quantitative results of the tests, we may quote Prof. Hollis' conclusion that the substitution of cast-steel fittings for cast-iron fittings was justified in this instance, not because cast-iron fittings could not have been made perfectly safe by the introduction of slip or expansion joints, but because it was cheaper to use cast steel, which would yield more readily to expansion and which would be safer at much higher tensile stresses, than to remodel the piping system. "The unreliability of cast iron in such a service," he says, "has nothing to do with the case; it is merely that the design usually adopted for steam piping does not quite fit cast iron."

The paper contributed by Prof. Edward F. Miller describes some experiments made to determine the effect of superheated steam on cast iron, gun iron, and steel, by comparative tension tests made on two specimens cut from each piece to be tested, one subjected to the action of superheated steam, and the other to show the original strength of the piece. The specimens exposed to superheated steam were subjected to an average gauge pressure of 93 pounds and an average temperature of 600 degrees F. for 260 to 520 hours. The results of the tests indicate that cast iron, gun iron and steel lose strength after exposure to superheated steam. The percentage loss in the case of the cast-iron specimens tested varied from 2.4 to 9.5, and in the case of the gun-iron specimens from 2.1 to 3.5. Tests on semi-steel specimens showed an average reduction of 0.4 per cent, and the reduction in the case of the four steel specimens tested varied from 1.5 to 24 per cent. While Prof. Miller does not feel justified in drawing many conclusions from the results of so few tests, he thinks the fact of the reduction in strength is fully established.

After briefly reviewing present knowledge of the subject and recording his own experiences with superheated-steam pipe fittings, both cast-iron and steel, Mr. Arthur S. Mann suggests a material which, he believes, will prove thoroughly satisfactory. "No doubt," he says, "a thoroughly sound steel cast-

ing is able to withstand highly superheated steam. So far as it has been possible to observe, superheated steam does not of itself initiate defects and it is not supposed that the sound metal undergoes a change, either chemically or structurally. But if there is an initial defect, superheated steam is active in bringing out the objectionable features of that defect. It may well be that the material within the body, and not a part of the actual metal, suffers through change of some sort. This material does not add to the strength of a casting, but it may serve to stop up holes if allowed to lie undisturbed.

"It would appear that some material better than the ordinary steel casting is desirable for high-temperature work. Such a material is found in gun iron. Gun iron is nothing more than a high-grade cast iron, which any first-class iron foundry can produce. Probably a tensile strength of 30,000 pounds is not needed in steam fittings, but iron of that quality is well adapted for 180 pounds steam pressure with 300 degrees superheat. Foundrymen are not afraid to attempt to produce this iron. No difficulty whatever was encountered in securing bids for valves made of the following mixture:

	Per cent.
Silicon	1.40 to 1.60
Phosphorus	0.20 to 0.40
Sulphur	0.06 to 0.09
Manganese	0.45 to 0.75
Total carbon	3.00 to 3.25

"It will be noted that the percentage of silicon and phosphorus are low. From such observations as have been thus far possible, it appears that certain elements in the iron are liable to cause trouble when present in excess, and perhaps the worst of these is silicon. It is at present going too far to say that every high-silicon iron will fail and that every low-silicon iron will prove successful, but there is much evidence pointing toward the correctness of such a surmise. In any event, iron of low silicon, low phosphorus and low carbon—in other words, gun iron—has proved successful."

A NEW PROCESS IN IRON METALLURGY.

THE PRODUCTION OF A SLOW-RUSTING IRON IN THE OPEN-HEARTH FURNACE.

Engineering News.

ONE of the most important additions to the list of structural materials, and the most interesting appearance in iron metallurgy, of recent years, is a remarkable product of the open-hearth steel furnace, placed on the market a short time ago by the American Rolling Mill Company, of Middletown, Ohio, under the name of "American Ingot Iron." While it is produced by the basic open-hearth process, in chemical composition and mechanical properties the ingot iron is closely similar to wrought iron. It differs from steel in having its carbon, manganese and silicon contents reduced to small fractions of the amounts found in ordinary soft steel. In a typical sample, the carbon and sulphur are each reduced to 0.02 per cent, manganese to 0.01 per cent, oxygen to 0.03 per cent, and phosphorus and silicon to slight traces. In appearance, strength (tests indicate an ultimate tensile strength of 47,000 to 49,000 pounds per square inch), and ductility the new metal is practically identical with wrought iron.

The prime quality of the ingot iron, however, is its resistance to corrosion. The ideal of the makers since they began the manufacture of low-carbon basic open-hearth steel sheets in 1901 has been the production of a low-carbon steel as soft and pure as feasible. Their ultimate success in producing on the large scale of the open-hearth steel furnace a material with rust-resisting qualities equivalent to those of the best wrought iron must be ranked as one of the triumphs of modern metallurgy. A few details of the process of manufacture and of its development from ordinary basic steel production are taken from *Engineering News* for January 6.

The earliest product of the mills was an ordinary soft steel, running 0.20 per cent carbon and 0.40 per cent manganese. Attention was first directed to the reduction of the carbon, and after some time of working this impurity was brought down to 0.10 per cent, giving a dead-soft metal, sheets rolled from which attained a special reputation. A demand for corrugated-steel culverts, which arose in 1904, was an incentive to still further reduction of impurities. The ferromanganese addition for clearing and recarburizing was cut down to what was thought a minimum consistent with producing workable metal, and steel running as low as 0.08 to 0.10 per cent carbon, 0.10 to 0.20 per cent manganese, and 0.03 per cent phosphorus was thus obtained. So far the reduction of the manganese had been undertaken only as part of the general scheme for lowering the impurities, but the publication of Dr. Cushman's research results, which showed manganese to be the most important element in the promotion of corrosion, led to experiments on the reduction of manganese which resulted in a decision to omit entirely the ferromanganese treatment. A long period of struggle with defective metal ensued, but eventually the difficulties, chief of which were the cracking of the edges of the sheets in rolling and poor galvanizing quality due to blistering, were completely overcome. The means may be very briefly indicated: it was learned by experience that the old idea of the need of manganese for giving good working quality in the hot condition is erroneous, and that the use of materials for purifying the molten metal of oxides and entrained gases accomplishes the same results.

The process by which the ingot iron is made is essentially very simple. "The same basic-lined furnace is used as in regular open-hearth practice, and practically the same charge is made, but the boiling is continued to an excessive degree, so as to oxidize the impurities more thoroughly than in ordinary steel practice. Naturally the process in its final stages goes on at a much higher temperature, on account of the higher melting point of the purer material. The usual ferromanganese recarburizer is omitted, and instead an addition of ferro-silicon or an equivalent substance is made to purify the bath of its entrained oxides. Finally, aluminium is added in the ladle, to carry out the gases dissolved in the fluid metal."

The furnaces now in use work entirely on cold pig iron, low in silicon and sulphur, of a grade slightly above the limiting phosphorus content for Bessemer working. A fairly large proportion of scrap is charged, some of it open-hearth scrap from the mill itself, but the larger part low-carbon steel turnings. Ore is not conveniently obtained, and whenever a sufficient quantity is available mill scale is substituted for ore in the charge. To produce a slag, limestone and fluorspar are used. A comparatively large amount of the latter flux is necessary to prevent the return of the phosphorus to the metal at the high temperature maintained toward the end of the process (3,000 to 3,100 degrees F.).

"The essentials of the melting process are the maintenance of an active basic slag, continuance of the boiling process until all foreign elements in the iron are reduced practically to zero, keeping up a sufficiently high heat for complete fusion and active boiling, and finally the treatment for removing oxygen and other gases by the addition of purifiers. In the removal of the impurities, ordinary oxidation and absorption by the basic slag plays the chief part, as usual. It is found advantageous, however, to add ore, or mill scale, for helping with the oxidation.

"The removal of oxygen (presumably contained in the metal as oxides) is most important. When this part of the process is imperfect, the metal is red-short and cracks on rolling. In ordinary steel making, spiegeleisen or ferromanganese have the chief duty of burning out the oxygen, reducing it from the metal both through their carbon and their manganese. In the present ingot-iron process, it has been found, the removal of the oxygen can be accomplished by various substances. Pig iron in itself

is a satisfactory means, but ferrosilicon is a more active agent, and at the American Rolling Mill Company's plant is largely used." The removal of other gases is accomplished by adding granular aluminium in the ladle, the quantity usually running well below 0.1 per cent. of the weight of the iron charged.

The average time from charging to tapping is 10 hours, an increase of several hours over steel furnace practice wholly traceable to the thorough elimination of impurities. The long duration of the melt necessarily increases the cost of the product materially over that of ordinary steel. Increased expenditure for fuel and, more important, increased plant and labor charges (the average output being admittedly brought down to two-thirds the usual figures) must appear in higher cost. The cost is increased also by the destructive effects of the high temperatures on furnace and ladle linings, brickwork, ingot molds, etc., all of which require more frequent renewal than in steel practice.

With watchful, intelligent control the process is in no way erratic or variable, and highly pure metal, carrying total impurities (xecept oxygen) amounting to 0.05 to 0.08 per cent. can be regularly produced. The best evidence obtainable points to strength and ductility identical with those of wrought iron. For a highly ductile metal with an ultimate strength of 47,000 to 50,000 pounds per square inch, the yield point is unusually high, 39,000 to 42,000 pounds per square inch. As to the relative resistance to corrosion of steel, wrought iron and ingot iron, sulphuric acid tests show ingot iron to have a resistance 40 to 60 times as great as that of steel and 20 to 40 times as great as wrought iron. The large ratios of resistance make it permissible to transfer the comparison to atmospheric rusting, after making a large reduction as a safety margin. It may be concluded that the ingot iron will resist atmospheric corrosion at least several times as well as mild steel, probably many times better, and markedly better than good grades of wrought iron.

Up to the present ingot iron has been produced only in the form of sheets. It has become popular in this form on account of its high degree of weldability and the ease with which it lends itself to the galvanizing and enamelling processes. A demand has arisen for ingot-iron wire, and in the new works of the American Rolling Mill Company, to be erected this year, provision will be made for wire drawing. Plates will be manufactured also, and it is possible that the plans will be extended to include the rolling of shapes. The new works will have at first four 65-ton furnaces, with room for extension to twelve or more. The present equipment includes only two 50-ton furnaces, with one furnace additional under construction.

COMPARATIVE COSTS OF ELECTRIC TRACTION SYSTEMS.

A COMPARISON OF INSTALLATION AND OPERATING COSTS OF SINGLE-PHASE AND THREE-PHASE LINES.

Ed. Tissot—International Congress on the Applications of Electricity.

A REPORT presented to the International Congress on the Applications of Electricity, held at Marseilles in 1908, by M. Ed. Tissot, gives some interesting comparative data of the cost of installation and operation of single-phase and three-phase traction systems. On account of his connection with the development of electric traction in Switzerland, this is a subject on which M. Tissot is entitled to speak with authority. The abstract of his report which we take from *The Electrician* for December 31, 1909, unfortunately does not deal with his discussion of the prime and maintenance costs of the various types of rolling stock, but is limited to the consideration of the cost of central- and sub-station distributing lines and trolley lines. His figures of costs are representative, of course, only of European systems, but the ratios between the

TABLE I. COST PER MILE (EXCLUDING COPPER).

	Line mounted on special poles.	Line mounted on poles of contact line.
Single phase, two wires	£165.5—£169.5	£ 88.0—£ 92.0
" " four wires	£217.5—£226.0	£143.0—£150.0
Three phase, three wires	£192.0—£198.0	£122.5—£128.5
" " six wires	£271.0—£282.0	£197.0—£208.0

TABLE II.—COST OF INSTALLATION OF TRANSFORMER SUB-STATIONS FOR OUTPUT OF 2,000 KILOWATTS.

(A) WITH BUFFER BATTERIES.

1.	Three phase, 45,000 volts, 50 c., to monophase,	15,000 volts, 15 c.	£85,800	For capacities of 3,000, 5,000 7,500 kilowatts multiply by 1.5—2.4—3.5.
1A.	" " 16,000 volts, 40 c., "	15,000 volts, 15 c.	£85,300	
2.	Single phase, 45,000 volts, 15 c., "	15,000 volts, 15 c.	£76,400	
2A.	" " 15,000 volts, 15 c., "	15,000 volts, 15 c.	£68,000	
3.	Three phase, 45,000 volts, 50 c., to three phase,	5,000 volts, 15 c.	£76,000	
4.	" " 45,000 volts, 15 c., "	5,000 volts, 15 c.	£72,300	
5.	" " 45,000 volts, 50 c., to direct current,	3,000 volts, — c.	£56,100	

(B) WITHOUT BUFFER BATTERIES—VOLTAGE TRANSFORMATION ONLY.

6.	Single phase 45,000 volts 15 cycles to single phase 15,000 volts 15 cycles	£6,800 to £7,600	The factors for 3,000, 5,000 and 7,000 kilowatts being 1.25, 1.70 and 2.30
	For 25 cycles and connection direct to contact line without intermediate apparatus	£4,000 to £5,000	
7.	Three phase 45,000 volts 15 cycles to three phase 5,000 volts 15 cycles	£7,200 to £8,000	
	For 50 cycles and direct connection to contact line without intermediate apparatus	£4,600 to £5,600	

TABLE III.—COST PER MILE OF CONTACT LINE (SECTION OF LATTER=100 SQUARE MILLIMETRES).

Arrangement of line, type of support, etc.	Current. One phase. Without copper.	One phase. With copper.	Three phase. Without copper.	Three phase. With copper.	Difference adverse to three phase. Without copper.	Difference adverse to three phase. With copper.
	£	£	£	£	%	%
(*a*) MAIN LINES.						
1. Single track, bracket poles, straight road	590	880	850	1,380	44	57
2. " " " 1,000 ft. curve	675	970	1,150	1,700	70	76
3. " " span supports, straight road	908	970	1,115	1,700	24	76
4. " " " 1,000 ft. curve	1,010	970	1,695	1,700	67	76
5. Double track, span supports, straight road	1,160	1,630	1,600	2,460	38	51
6. " " " 1,000 ft. curve	1,300	1,780	2,220	3,100	71	74
(*b*) SECONDARY LINES.						
1. Single track, bracket poles, straight road	480	695	2,220	3,100	71	74
2. Double track " " "	622	842	2,220	3,100	71	74
(*c*) STATION INSTALLATIONS.						
1. Large stations with 10 per cent. track	728	880	945	1,192	30	36
2. Small " " 30 "	965–1,030	1,200	1,265–1,320	1,655	30	38
(*d*) IN TUNNELS.						
1. Single track	322	704	450	1,075	40	53
2. Double track	510	1,075	830	1,785	63	66

TABLE IV.—INDIVISIBLE COSTS.

	Single phase.	Three phase.	Difference adverse to three phase.
Large stations	£2,560	£3,140	23 per cent.
Small stations	£540—£748	£668—£920	24 per cent.

costs of single- and three-phase installations have a universal significance.

"*Central stations.*—For very long lines it is advantageous to instal three-phase 50-cycle generating plant; 50,000 volts form a convenient pressure for transmission purposes, and is lowered both in voltage and frequency at the various points of transformation to suit the requirements of the system.

"*Transmission line.*—The transmission line is independent of the actual traction conductors, and may or may not be carried on the same poles as the latter. The use of a common pole system enables considerable reduction to be made in the cost of installation, this being well illustrated by Table I. In the latter the lower figures refer to conductors of less than 6 millimetres diameter, the higher figures being applicable to wires of over 6 millimetres diameter. The costs per mile here shown refer to a single-phase 45,000-volt system, and do not include copper costs. The actual cost per mile of such a line depends greatly on local conditions, but the comparative costs employing independent and common poles respectively are as shown.

"*Sub-stations.*—Table II shows the installation costs of a 2,000-kilowatt transformer sub-station on various systems, single phase and three phase, and *(a)* with a buffer battery, both voltage and frequency being transformed, *(b)* without a buffer battery, pressure only being

transformed. Constants are also given whereby the stated costs can be corrected to suit 3,000-, 5,000- and 7,000-kilowatt sub-stations respectively. The remainder of the table is self-explanatory.

"*Trolley line.*—Table III gives the cost of the contact conductor for single- and three-phase systems. The actual costs, of necessity, vary from one country to another, but the relative magnitudes of the costs of the two systems remain fairly constant. The construction assumed in Table III is catenary suspension with iron poles placed on an average 165 feet apart. The poles are assumed to conform to the general Swiss practice, and carry, in addition to the contact wire, a higher tension transmission line, the feeder line and telegraph and telephone wires. The cost of ordinary single-wire direct-current trolley conductors is nearly equal to that of single-phase lines.

"The cost of electric lighting along the track is practically identical for single- and three-phase systems.

"The costs indivisible to a 'per mile' basis (*e. g.*, cost of stations) are practically as shown in Table IV. The net result of Tables III and IV is to show that the cost of the trolley conductor is much higher in three-phase than in one-phase systems, the difference in extreme cases exceeding 70 per cent.

"*Operating costs.*—There is a scarcity of precise data under this heading, since the number of electric railways operated under the various systems and under sufficiently similar conditions is too small to allow of a very reliable comparison of their working costs. Roughly speaking, the difference between the systems in this respect is small.

"Though exact figures cannot be given, there are certain reliable general conclusions enabling a fairly accurate appreciation of the problem.

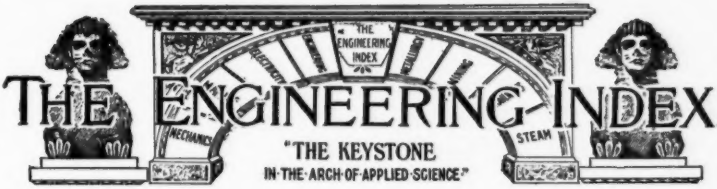
"*Generating station working costs.*—The operating costs of direct-current generating equipments are usually rather higher than those of the alternative systems. High-tension machines and their accessories are more delicate and hence more liable to derangement in the case of direct-current installations. Such costs as wages, general stores, etc., are the same for all systems.

"*Transmission and feeder lines.*—The maintenance of a three-phase line is naturally heavier than that of a single-phase or direct-current line, owing to the greater number of conductors required. The advantage lies with single-phase lines if the maintenance cost be referred to the kilowatt-hours or ton-miles per annum.

"*Sub-stations.*—The operating costs under this heading are invariably highest for direct-current systems owing to the higher number of sub-stations necessitated by the low pressure of generation and transmission. Next come three-phase equipments, mono-phase current being the best in this respect. If the sub-stations have also to act as buffers, the total operating cost is sensibly the same for all three systems. It will be slightly higher for the direct-current plant. On the contrary, if the sub-stations have merely to lower the voltage of transmission, alternating systems present considerable advantage over continuous-current equipments, since static transformers may be used. Single-phase current is then the most advantageous.

"*Trolley lines.*—In this part of the equipment, also, single-phase current holds the advantage. Not only is the maintenance cost a minimum, but the interest and sinking fund charges per kilowatt-hour or per ton-mile are less than for three-phase or direct current.

"*Rolling stock.*—From the point of view of dead weight—and, therefore, of energy expended per ton-mile—the three-phase system is the most economical: then follow the continuous current, and finally the single-phase systems. On the other hand, the single-phase system is superior to the continuous-current system, and still more superior to the three-phase system in respect of energy consumed during acceleration. The maintenance of single-phase motors is rather high on account of the collector gear, but bearing maintenance is no longer a matter of such vital importance, the air-gap being greater in single- than in three-phase machines."



The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING.

BRIDGES.

Architecture.

Bridge Design from the Architect's Standpoint. Charles W. Killam. A detailed consideration of types aiming to discover the characteristics that please. Ills. 5000 w. Harvard Engng Jour. Nov., 1909. No. 9950 D.

Bascule.

A Study of an Electrically Operated Bascule Bridge (Etude d'un Pont roulant électrique). J. Paquet. Detailed mathematical discussion of the method of design. Ills. 11000 w. All Indus—Nov., 1909. No. 10214 D.

Drawbridges.

The Fabrication of Heavy Curved Drawbridge Girders. Illustrates and describes work on a 6-track drawbridge over the Chicago drainage canal, one of the heaviest drawbridges ever built. 2000 w. Eng Rec—Dec. 18, 1908. No. 10161.

Floors.

Tables and Charts for the Calculation of the Strength of Single-Span Railway-

We supply copies of these articles. See page 809.

Bridge Floors (Tableaux et Graphiques pour les Calculs de Résistance des Tabliers métalliques sous Rails à une seule Travée). M. de Boulougne. Considers the stresses under various types of loading. Ills. 3000 w. Rev Gen d Chemins de For—Nov., 1909. No. 10208 G.

Inspection.

Bridge Inspection Disclosures. Information from the report of Herbert C. Keith showing defects in design that cause trouble. 3500 w. Eng Rec—Dec. 11, 1909. No. 10007.

Reinforced Concrete.

The Delaware River Concrete Bridge, Slateford-Hopatcong Cut-off; Delaware, Lackawanna & Western R. R. Illustrated detailed description of the design and construction. 2500 w. Eng News—Dec. 30, 1909. No. 10505.

The Calculation of Continuous Bow-string Trusses (Note sur le Calcul des Bow-Strings continus). Henry Lossier. Discusses the application of this type of structure to a reinforced-concrete viaduct. Ills. Plate. 4500 w. Génie Civil—Nov. 27, 1909. No. 10231 D.

Steel.

The Construction of a Four-track Truss Bridge with Solid Floor; Chicago & Oak Park Elevated Ry. Illustrated detailed description. 2500 w. Eng News—Dec. 9, 1909. No. 9988.

Suspension.

Suspension Bridge of 600-Ft. Span Across the Culebra Cut of the Panama Canal. A. S. Zinn. Illustrated description of a temporary structure for use in the construction of the Panama Canal. 2000 w. Eng News—Dec. 16, 1909. No. 10114.

Viaducts.

The Valley City Viaduct. C. R. Mandigo. Illustrated description of a steel viaduct on the N. Pac. Ry. in North Dakota. 2500 w. Harvard Engng Jour—Nov., 1909. No. 9949 D.

Construction of Lethbridge Viaduct, Crow's Nest Branch, Canadian Pacific Railway Company. C. N. Monsarrat. Illustrated description of a steel viaduct over the Belly River, 5,327 ft. long, with a maximum height of 314 ft. from the bed of the river to the base of the rail. Plates. 7500 w. Can Soc of Civ Engrs—Dec. 2, 1909. No. 10085 N.

CONSTRUCTION.

Bins.

A Cement Storage Bin of Reinforced Concrete. A. D. Mellor. Illustrated description of a bin at Alsen, N. Y., comparing with old bins. 1700 w. Cement Age—Dec., 1909. No. 10315 C.

Coal Bunkers.

A Steel Coke Building. Illustrated description of a storage building in Toronto, Ontario, made with a steel framework, roof and hoppers, and brick walls. 1000 w. Eng Rec—Dec. 25, 1909. No. 10441.

Concrete.

Cost of Two Methods of Concrete Construction. Mason D. Pratt. Illustrated description of two similar barns built at Harrisburg, one constructed by casting in place, the other by molding on the ground and afterwards erecting, comparing costs. 1600 w. Eng Rec—Dec. 4, 1909. No. 9897.

Details of Concrete Encasement for Elevated Railway Structure and of Special Forms Employed in Its Construction. Illustrated detailed description of work in Boston. 1600 w. Engng-Con—Dec. 15, 1909. No. 10103.

Concrete in Water-Works Construction. William Curtis Mabee. Read before the Am. Water-Works Assn. Explains its advantages, the best water-proofing methods, and describes examples of concrete construction. 4000 w. Munic Engng—Dec., 1909. No. 9822 C.

See also Levees, under WATERWAYS AND HARBORS.

Concrete Coloring.

Experiments in Coloring Concrete. Charles E. Pellew. Deals with the materials that may be used for body coloring, where the pigment is incorporated in the concrete before mixing. 1700 w. Cement—Nov., 1909. No. 9954 C.

Contractors' Plants.

See Excavation, under CONSTRUCTION; and Oil Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Contracts.

Building Agreements. William B. Bamford. The discussion is limited to agreements for the construction of buildings. 1600 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10472 E.

Cost Data.

The Use—and Abuse—of "Cost Data." Editorial on the misuse of such statements. 1500 w. Eng News—Dec. 23, 1909. No. 10354.

Depreciation.

Depreciation Allowances on Equipment for Construction Work, U. S. Government Departments. Gives an outline of the general method used by the U. S. Reclamation Service. 1000 w. Eng News—Dec. 2, 1909. No. 9856.

Excavation.

A Novel Locomotive Rock Drill and a Remarkable Drilling Record. Frank Richards. Gives an interesting report of rock-drill work in connection with the improvement of the Detroit River, in which deep holes were drilled without changing steel. 1200 w. Eng News—Dec. 2, 1909. No. 9852.

A Large Blast at Morena Dam, California. M. M. O'Shaughnessy. An account

of a very successful explosion in which 180,000 tons of granite rock were displaced. 1200 w. Eng News—Dec. 30, 1909. No. 10510.

Moving Earth with Elevating Graders and Dump Wagons. Gives a report of results obtained with grading machines at the Stanley Lake Dam, near Denver, with costs. 1500 w. Eng Rec—Dec. 11, 1909. No. 10009.

The Cost of Hauling with Traction Engines and Dump Wagons as Compared with Hauling with Horses. Abstracted from a report by the Construction Service Co., of New York City, to the Troy Wagon Co., of Troy, Ohio. Ills. 6500 w. Engng-Con—Dec. 8, 1909. No. 10026.

Factories.

The Nashawena Mills, New Bedford, Massachusetts. Illustrated description of slow-burning mill construction and equipment for large cotton mills. 2500 w. Eng Rec—Dec. 4, 1909. No. 9892.

Floors.

Floors with Seidel Separately Moulded Joists (Formsteinbalkendecke "System Seidel"). Rich. Wuczkowski. Describes the production of the concrete joists and their use in construction. Ills. 3500 w. Beton u Eisen—Nov. 23, 1909. No. 10287 F.

Gas Holders.

The Gas Holder. Lewis Vincent. Illustrated general description of the structure. Discussion. 5500 w. Pro Engrs' Soc of W Penn—Dec., 1909. No. 10338 D.

A Large Columnless Gasholder. Illustrated description of a spiral-guided gasholder, with storage for 3½ million cubic feet, erected in England. 1500 w. Engr, Lond—Dec. 3, 1909. No. 10069 A.

Piling.

Concrete Foundation Piles—Types, Uses and Advantages. Harrison L. Garner. Deals only with piles as used in the foundations for buildings. Ills. 3500 w. Wis Engr—Dec., 1909. No. 10323 D.

Steel Sheet Piling. Thomas Curtis Clarke. Explains the uses of this material illustrating and describing forms, the methods of driving, and related matters. 2500 w. Harvard Engng Jour—Nov., 1909. No. 9948 D.

Reclamation Work.

Proposed Plans for the St. Francis Valley Drainage, a Statement of Methods of Construction and Some Estimates of Costs. Map. 5500 w. Engng-Con—Dec. 22, 1909. No. 10347.

Regulations.

Comments on the Swiss Regulations for Reinforced - Concrete Construction (Erläuterungen zu den Vorschriften über Bauten in armiertem Beton). F. Schüle. Explanatory comment on some of the regulations by the President of the Commission which drafted them. Ills. Serial. 1st part. 2000 w. Schweiz Bau—Nov. 6, 1909. No. 10270 B.

Reinforced Concrete.

Deformed Bars vs. Round Rods Anchored for Reinforced Concrete. J. H. Toupet. Discusses the advantages and disadvantages of the shapes used for reinforcement. Ills. Discussion. 10000 w. Pro Engrs' Soc of W Penn—Dec., 1909. No. 10337 D.

Industrial Applications of Reinforced Concrete. M. M. Sloan. First of a series of articles discussing its peculiar adaptability to use in factory buildings. Ills. 2500 w. Engineering Magazine—Jan., 1910. No. 10489 B.

The Limitations of Reinforced-Concrete Design. W. H. Thorpe. Discusses the nature of stresses and how cost is affected by design. 2000 w. Engng—Dec. 3, 1909. No. 10060 A.

Reinforced Concrete for Textile Mill Construction. J. P. H. Perry. Presents the advantages of this material, giving facts based on experience. Ills. 4500 w. Cement—Nov., 1909. No. 9955 C.

The Construction of the Concrete Steel Surety Building, Muskogee, Okla. Donald D. Smith. Illustrated description of an 8-story building having a reinforced-concrete skeleton with long span arches. 2000 w. Cement—Dec., 1909. No. 10432 C.

The Construction of the Surety Building, Muskogee. Donald D. Smith. Illustrated description of method of erecting a reinforced-concrete skeleton building in Oklahoma, on a corner of two important streets, where material handling had to be studied. 3000 w. Eng Rec—Dec. 11, 1909. No. 10005.

See also Bins, Floors, and Regulations, under CONSTRUCTION; Siphons, under WATER SUPPLY; and Piers, under WATERWAYS AND HARBORS.

Retaining Walls.

Concrete Wall at Chattanooga. Illustrated description of a recent construction in connection with a street on a steep hillside. 1800 w. Munic Jour & Engr—Dec. 1, 1909. No. 9787.

Steel.

A Government Balloon House. Illustrated description of a steel building at Fort Omaha, Nebraska, intended to shelter a full-sized dirigible balloon when inflated. 2500 w. Eng Rec—Dec. 4, 1909. No. 9895.

See also Coal Bunkers, under CONSTRUCTION.

Tunnels.

Subaqueous Section of the Detroit River Tunnel. An illustrated article covering the entire design and construction of this section. 4000 w. Eng Rec—Dec. 18, 1909. Serial. 1st part. No. 10156.

The Bergen Hill Four-Track Tunnels. Erie Railroad. Describes the driving and

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lining of these wide span tunnels, and the difficulties due to conditions. Ills. 2000 w. Eng Rec—Dec. 18, 1909. No. 10160.

Underpinning.

Underpinning the Cambridge Building, New York City. T. Kennard Thomson. An illustrated account of the settlement of this building during the construction of the Pennsylvania tunnel under 33d St., and the methods used to stop the damage. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10471 E.

MATERIALS OF CONSTRUCTION.

Cement.

A Comparison of Reports on Tests of the Same Cement by Various Laboratories. Alexis Saurbrey. Tabulated results, with reports of tests. 2500 w. Eng News—Dec. 9, 1909. No. 9983.

Recording Photographically the Setting of Cement. H. Burchartz. Brief descriptions of apparatus formerly tried to record the time of setting, with illustrated description of the photographic method. 1200 w. Eng Rec—Dec. 11, 1909. No. 10010.

Concrete.

Sand, Gravel and Crushed Stone Available for Concrete Construction in Manila. George I. Adams. Discusses the nature of the materials commonly used, showing where better ones may be obtained, and indicating their relative efficiency in concrete construction. Plates. 4000 w. Philippine Jour of Sci—Sept., 1909. No. 10497 N.

The Effect of Alkali on Concrete. George Gray Anderson. Discussion with special reference to irrigation work in the arid regions, where the soil and water often contain alkali. 5500 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10473 E.

See also Mortar, under MATERIALS OF CONSTRUCTION; and Sewers, under MUNICIPAL.

Mortar.

Mortar and Concrete Mixtures (Ueber Mörtel und Betonmischungen). Karl Stöckl. Discusses the proportioning of mortar and concrete for various purposes. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Nov. 27, 1909. No. 10286 D.

Paints.

Paint Properties for Protecting Metal. Discusses the general qualities of paints for protecting metal surfaces, and the particular properties of several selected paints. 3500 w. Met Work—Dec. 25, 1909. No. 10433.

Reinforced Concrete.

A Five Years' Test of an Reinforced Concrete Arch of Sixty-six-Foot Span. From a recent lecture by Herr Hoch, before the Wuerttemberg Engng. Soc., describing a test arch construction and observations for five years, after which time it failed. Ills. 2000 w. Cement—Dec., 1909. No. 10431 C.

An Experimental Study of Reinforced Concrete in Compression. Translation from *Beton und Eisen*, of a study made by Messrs. Schinke and Loeser on small reinforced prisms and columns. 2000 w. Cement—Nov., 1909. No. 9953 C.

Timber.

Dry Rot the Cause of Collapse of a Factory Building During a Fire. Ira H. Woolson. Reports results of investigation of a factory fire in New York City, showing that dry rot in the timber posts had caused the failure. Ills. 1600 w. Eng News—Dec. 2, 1909. No. 9855.

MEASUREMENT.

Cement Testing.

Progress in the Methods of Testing Hydraulic Cements. Official report presented by R. Feret to the Int. Assn. for Testing Materials. Examines the principles underlying the methods. 3500 w. Cement Age—Dec., 1909. No. 10313 C.

Stream Gauging.

Making Weir Measurements in Open Streams. Franklin van Winkle. Explains how to build the ordinary rectangular weir and modifications of the standard weir, and methods of comparing the flow of water over weirs and dams. Ills. 2500 w. Power—Dec. 28, 1909. No. 10465.

MUNICIPAL.

City Planning.

Town Planning Systems. W. R. Davidge. Plans of several systems, with brief discussions and general conclusions. 2500 w. Surveyor—Nov. 26, 1909. No. 9935 A.

The Planning and Laying-Out of Public Places. H. Inigo Triggs. Deals with the planning of spaces in cities, especially from the architectural point of view. Ills. Discussion. 11500 w. Jour Roy Inst of Brit Archts—Nov. 20, 1909. No. 10042 B.

See also Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Drainage.

Storm Drainage at Street Intersections. J. Heiskell Weatherford. Read before the Am. Soc. of Munic. Imp. Discusses the convenience of vehicular and foot traffic, illustrating and describing work at Memphis, Tenn. 2500 w. Munic Engng—Dec., 1909. No. 9819 C.

See also Sewers, under MUNICIPAL.

Pavements.

Pavements and Grade Limitations. S. C. Thompson. Concerning the kinds of pavements that have been found satisfactory for specified grades in New York City. 1500 w. Munic Jour & Engr—Dec. 8, 1909. No. 9958.

Center Walks Supplemented by Back Alleys in Place of Roadways and Side-

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walks in Venice, Cal. H. M. Meinell. Illustration and brief description of an innovation for short streets, adopted at this seaside city. 500 w. Eng News—Dec. 2, 1909. No. 9849.

Creosote Oil for Wood Block Pavements. James Nisbet Hazlehurst. Read before the Am. Soc. of Munic. Imp. On the proper treatment of the wood blocks. 1700 w. Munic Engng—Dec., 1909. No. 9820 C.

Concrete Blocked Pavement. W. E. Putnam. An illustrated account of methods of construction, machinery and tools used in Knoxville, Tenn. 2500 w. Munic Jour & Engr—Dec. 1, 1909. No. 9790.

Concrete Foundations from Paving Blocks. Illustrated description of work in New York City, giving details and costs. 2800 w. Munic Jour & Engr—Dec. 1, 1909. No. 9789.

Concrete Pavement Foundation. George C. Warren. Discusses proportions of concrete ingredients, advocating thinner concrete except on weak spots, and gives specifications. 2500 w. Munic Jour & Engr—Dec. 1, 1909. No. 9788.

Standard Specifications of the New York State Highway Commission for Brick Pavement. Gives revised specifications recently issued. Ills. 2200 w. Engng-Con—Dec. 15, 1909. No. 10104.

Public Baths.

The Repeated Use of Water in Public Baths (Die angestrebte Wiederverwendung des gebrauchten Bassinwassers unter Berücksichtigung der bei Untersuchungen der Berliner Schwimmbäder gemachten Erfahrungen). Herr Proskauer. A discussion based on purification tests in Berlin. 5000 w. Gesundheits Ing—Nov. 13, 1909. No. 10291 D.

Refuse Disposal.

The Collection and Disposal of House Refuse. John S. Brodie. Read before the Roy. San. Inst. Brief consideration of sanitary methods of collecting and disposing of wastes. 2500 w. Surveyor—Dec. 10, 1909. No. 10182 A.

The Prahran Refuse Destructor, Victoria. Illustrated description of a special electrical synchronizing induction plant. 2500 w. Aust Min Stand—Nov. 3, 1909. No. 10169 B.

Kori Incinerating Furnaces for Hospitals and Abattoirs (Fours incinérateurs, Système Kori, pour Hôpitaux et Abattoirs). M. Bousquet. Describes several installations of this furnace. Ills. 2000 w. Génie Civil—Nov. 20, 1909. No. 10228 D.

Roads.

Tests of Philippine Road Materials. George I. Adams. An account of investigations and tests made to obtain the best possible material and with a view to convenient transportation. 3000 w. Philippine Jour of Sci—Sept., 1909. No. 10496 N.

Solving the Road Problem in Virginia. William Romaine Tyree. Describes the physical formation of the state, discussing the advantages and disadvantages of road making and the materials available. 3000 w. Mfrs Rec—Dec. 2, 1909. No. 9809.

Improved Highways and How to Secure Them. Charles H. Hoyt. Brief review of the history of road building, and an account of what has been accomplished by the Office of Public Roads, in Washington. Ills. 4500 w. Cornell Civ Engr—Dec., 1909. No. 10316 C.

Extracts from Papers before the British Road Conference of 1909. Abstracts of papers on various phases of road construction and maintenance. 8000 w. Eng News—Dec. 16, 1909. No. 10115.

Standard Details of the New York State Highway Departments for State and County Roads. Gives new standard details for highway work, recently issued. 1500 w. Engng-Con—Dec. 15, 1909. No. 10105.

The Possibilities of Portland Cement as a Road Material. Logan W. Page. Read before the Assn. of Am. Port. Cement Mfrs. Discusses the Roman roads and their construction, and types of construction possible with concrete. 2000 W. Eng News—Dec. 23, 1909. No. 10355.

The Mechanics of Dust. C. H. W. Biggs. Discusses dust in its relation to roads and vehicular traffic, and the means of remedying the annoyance. 4500 w. Soc of Engrs—Dec. 6, 1909. No. 10340 N.

Bituminous Dust Preventives. W. Gavett. Discusses surface treatments and permanent binders, their advantages, and related matters. 3000 w. Cornell Civ Engr—Dec., 1909. No. 10317 C.

Specifications of the New York State Highway Department for Bituminous Macadam and Characteristics Required of the Bituminous Materials. Gives recently revised specifications for the building of state highways. 3500 w. Engng-Con—Dec. 8, 1909. No. 10022.

Three Years of Experience with Oiling Roads. Frederic A. Reimer. Read before the Am. Soc. of Munic. Imp. Gives results and concludes that the quality of the oil is of far more importance than the method of application. 1200 w. Munic Engng—Dec., 1909. No. 9821 C.

Methods and Cost of Sprinkling Road Surfaces with Oil. W. A. Gillette. An illustrated account of the best practice, in California. 2000 w. Engng-Con—Dec. 8, 1909. No. 10023.

The Maintenance of Common Roads (Per la Manutenzione delle Strade ordinarie). Italo Vandone. Discusses materials and methods for the maintenance of macadam roads. 3500 w. Monit Tech—Nov. 20, 1909. No. 10246 D.

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Sanitation.

Education in Municipal Sanitation. H. N. Ogden. Read before the Am. Soc. of Munic. Imp. Outlines the need of educating the public to an appreciation of the rights of others in sanitary matters, thinking the hope is in educating the children. 2000 w. Munic Engng—Dec., 1909. No. 9818 C.

Progress in Sewerage and Sanitation. George C. Whipple. Read before the Am. Soc. of Munic. Imp. A review of progress since 1907, showing advance in all branches. 2500 w. Munic Engng—Dec., 1909. No. 9817 C.

Sewage Disposal.

Importance of Best Methods in Sewerage. Calvin W. Hendrick. From a lecture on the Baltimore sewerage work. 2000 w. Mfrs' Rec—Dec. 30, 1909. No. 10495.

Factors Influencing the Selection of a Scheme of Sewage Treatment. Sidney R. Lowcock. Read before the Assn. of Mgrs. of Sewage Disposal Works. Gives things important in determining the scheme to be adopted. 2000 w. Surveyor —Dec. 10, 1909. No. 10183 A.

Sewage Disposal at Country Houses. Abstract of a paper by John D. Watson, read before the Inst. of San. Engrs. An outline of the best plans for such plants. 3500 w. Eng Rec—Dec. 18, 1909. No. 10157.

Standards for Sewage Effluents. John C. Thresh. Read before the Assn. of Mgrs. of Sewage Disposal Works. Discusses the question of what standard can be maintained, recommending certain tests. 3000 w. Surveyor. Dec. 17, 1909. No. 10424 A.

Disinfection of Sewage and Sewage Effluents. Earle B. Phelps. Read before the Am. Soc. of Munic. Imp. Deals with purification processes and their costs. 2500 w. Munic Engng—Dec., 1909. No. 9816 C.

Sewage Clarification Tanks. Illustrates and describes two recent German devices. The Kessel, operating by siphon action, and a sedimentation tank of high efficiency. 1500 w. Munic Jour & Engr—Dec. 8, 1909. No. 9956.

A Chemical Study of Paris Sewage, April to October, 1908 (Etude chimique de la Gadone de Paris d'Avril à Octobre 1908). E. Damour. Reports an investigation undertaken to determine the possibility of utilizing or treating Paris sewage for fertilizing purposes. 10000 w. Bul Soc d'Encour—Oct., 1909. No. 10206 G.

See also Sanitation, under MUNICIPAL.

Sewer Gas.

Explosions of Sewer Gas in New York City. A. A. Breneman. An account of a violent explosion in New York City on Oct. 7, discussing the cause. 2500 w. Eng News—Dec. 2, 1909. No. 9851.

Sewers.

Asphalt Joints for Sewer Pipe. Carl Henneking. Gives an account of six years' experience with asphalt joints in Germany. Ills. 1200 w. Eng Rec—Dec. 25, 1909. No. 10438.

Materials for Sewer Inverts. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. An account of an experiment made to determine whether a vitrified lining is necesary in a concrete sewer, and the relative wearing qualities of concrete as compared with a vitrified pipe. 700 w. Eng Rec—Dec. 4, 1909. No. 9891.

Some Notes on the Design and Construction of an Intercepting Sewer. A. C. D. Blanchard. Illustrates and describes features of the work at Toronto. 3000 w. Ap Sci—Dec., 1909. No. 10468 C.

Utilizing a Creek Valley Bed for a City Sewer. Harlow Gale. Explains conditions at Minneapolis and the reasons for the system adopted. 1200 w. Eng Rec—Dec. 25, 1909. No. 10442.

The Construction of the Bronx Storm Relief Sewer. Illustrated description of extensive work in progress in the northern part of New York City. 4000 w. Eng Rec—Dec. 4, 1909. No. 9894.

Street Cleaning.

A Study of Street-Cleaning Conditions in Boston, with Data on the Cost of Snow Removal, Push-Cart Patrol System, Machine Sweeping and Maintenance of Horses. 5500 w. Engng-Con—Dec. 22, 1909. No. 10348.

Rubbish and Snow Removal. Illustrated account of methods in New York City, with extracts from an address by Commissioner William H. Edwards. 3500 w. Munic Jour & Engr—Dec. 22, 1909. No. 10318.

WATER SUPPLY.

Dams.

The Shoshone Dam, U. S. Reclamation Service, near Cody, Wyo. H. N. Savage. Illustrated description of a concrete dam of up-stream curve, in connection with the Shoshone irrigation project. 1200 w. Eng News—Dec. 9, 1909. No. 9980.

Dams for the Catskill Water Works. Alfred D. Flinn. A brief illustrated discussion of the principal dams for this increased supply for New York City. 2000 w. Harvard Engng Jour—Nov. 1905. No. 9951 D.

The Partial Failure Through Undermining of the Zuni Dam, New Mexico. An illustrated account of the accident, which occurred Sept. 6, 1909, based on official investigations, with a general description of the dam. 3500 w. Eng News —Dec. 2, 1909. No. 9848.

See also Pipe Lines, under WATER SUPPLY.

We supply copies of these articles. See page 800.

Filtration.

The Policy of Water Filtration. George C. Whipple. Address before the N. Y. Assn. of Private Water Co.'s. Discusses the demand for pure water and the best way to secure it. 3000 w. Eng Rec—Dec. 25, 1909. No. 10440.

Design and Operation of a Mechanical Filter Plant. The Bristol-Warren pumping and filter plants in Rhode Island are illustrated and described. 3000 w. Eng Rec—Dec. 18, 1909. No. 10162.

The New Water Filtration Plant at Toledo, Ohio, with Data on Contract Methods and Cost. B. M. Baker. Illustrates and describes a $900,000 filtration plant. 5000 w. Engng-Con—Dec. 1, 1909. No. 9840.

See also Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Fire Protection.

Fire Protection Engineering. Greely S. Curtis. Aims to show the practical advantages that would result from a more general application of engineering methods in fire department work. 14000 w. Sib Jour of Engng—Dec., 1909. No. 10141 C.

Irrigation.

The Reclamation of the Arid Lands of the West. An illustrated review of the projects for irrigating arid lands, both past and under present construction. 2800 w. Sci Am—Dec. 11, 1909. No. 9989.

The Reclamation Project of the Idaho Irrigation Company. Map and illustrated detailed description of a project under development in Southern Idaho. 5500 w. Eng Rec—Dec. 25, 1909. No. 10434.

See also Flood Protection, under WATERWAYS AND HARBORS.

Pipe Corrosion.

Protection of Underground Pipes from Electrolysis. Albert F. Ganz. Considers methods of protection from corrosion caused by stray electric currents. Especially considers cement joints. 11000 w. Pro Age—Dec. 15, 1909. No. 10097.

Pipe Laying.

On the Depth of Laying Water Pipe. Abstract of a report of a Committee of the New England Water Works Assn. 1200 w. Eng News—Dec. 23, 1909. No. 10352.

Pipe-Line Design.

The Design of Pipe-Line Networks for City Water Supplies (Die Berechnung von Rohrnetzen städtischer Wasserleitungen). H. Mannes. Theoretical mathematical discussion. Ills. Serial. 1st part. 4500 w. Gesundheits-Ing—Nov. 20, 1909. No. 10293 D.

Pipe Lines.

The Pipe Line of the Cañon City Water Supply System. Illustrated detailed description of new works, including a diverting dam and inlet basin, 1500 ft. of 30-in. steel pipe, to a settling basin, and about 35,000 ft. of a 30-in. wood-stave pipe, leading to a purification plant. 5500 w. Eng Rec—Dec. 4, 1909. No. 9889.

An Interesting Pipe Line Installation in Utah. Leroy A. Palmer. Illustrates and describes a high-pressure pipe line at American Fork, Utah, and the method of construction. 1000 w. Min Wld—Dec. 11, 1909. No. 10034.

Stone-Ware Tiles under Streets (Die Ausfuhrung und wasserdichte Herstellung der Steinzeugstrassenkanäle). Herr Draack. Discusses details of construction of stone-ware conduits. Ills. 2200 w. Gesundheits-Ing—Nov. 6, 1909. No. 10290 D.

Pollution.

Experiments on the Passage of Bacteria Through Soil. Notes from an account by Dr. Fritz Ditthorn and Dr. Arthur Luerssen concerning tests made in Berlin to ascertain how near a well could be to a broken sewer pipe without contamination. From *Gesundheits Ing.* 1200 w. Eng Rec—Dec. 4, 1909. No. 9896.

Reservoirs.

The Hill View Reservoir, Catskill Water Supply. Plan, section, and brief description. 1200 w. Eng Rec—Dec. 18, 1909. No. 10159.

The Kensico Reservoir, Catskill Water Supply. Map and illustrated description of this reservoir near White Plains, N. Y., a part of the system for the supply of New York City. 1500 w. Eng Rec—Dec. 25, 1909. No. 10443.

Siphons.

Reinforced Concrete Siphon of Albelda on Irrigation System of Aragon and Catalogne (Spain). B. A. Etcheverry. Illustrated general description of the conduit, and of the method of construction. 1000 w. Cal Jour of Tech—Dec., 1909. No. 10334.

Springfield, O.

The Water Supply of Springfield, Ohio. Paul Hansen. Description and discussion of the system, its sources of supply, the quality of the water, and conclusions. Ills. 4000 w. Eng Rec—Dec. 11, 1909. No. 10011.

Tunnels.

Proposed Delivery System of the Catskill Water Supply. Plan, profile and description of the system proposed. 1500 w. Eng Rec—Dec. 11, 1909. No. 10006.

A Proposed Water-Supply Tunnel Under New York City. Map and description of the new and old schemes for the distribution of the Catskill water supply. 1200 w. Eng News—Dec. 9, 1909. No. 9987.

Water Works.

See Concrete, under CONSTRUCTION.

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WATERWAYS AND HARBORS.

Barge Canal.

The Barge Canal—Its Construction. Frank M. Williams. Read before the N. Y. State Waterways Assn. 2000 w. Barge Canal Bul—Dec., 1909. No. 10467 N.

Canals.

The Advantages, Strategical and Commercial, of a Battleship and Ocean-Going Steamer Canal Between the Forth and the Clyde. Sir C. Campbell. A discussion of the proposed mid-Scotland ship canal, with two maps, illustration, and general discussion. 7500 w. Jour Roy U S Inst—Nov., 1909. No. 9847 D.

See also Barge Canal, under WATERWAYS AND HARBORS.

Dry Docks.

Design for Concrete Dry Dock at Pearl Harbor, Hawaii, for the United States Navy. R. E. Bakenhus. Illustrated detailed description of a new dry-dock now under construction, as nucleus of a first-class naval base. 3500 w. Eng News—Dec. 9, 1909. No. 9984.

Fishguard.

Fishguard Harbor. Illustrated detailed descriptions of work recently executed in the development of this harbor and also work to be constructed in the immediate future. Plate. 3500 w. Engr, Lond—Dec. 3, 1909. No. 10068 A.

Flood Protection.

Flood Prevention and Land Fertilization by Basin Irrigation in the Sacramento-San Joaquin Valley. Map and description of this scheme as given by A. D. Foote in a paper presented to the Am. Soc. of Civ. Engrs., with editorial comments. 4500 w. Eng News—Dec. 9, 1909. No. 9986.

France.

Interior Navigation in France (Le Réveil de la Navigation interieure en France). A. Rangères. A review of the projects of the General Council of Roads and Bridges. 5500 w. Génie Civil—Nov. 13, 1909. No. 10225 D.

Levees.

Protecting Levee Slopes with Concrete. Illustrated detailed description of work at Cincinnati, Ohio. 500 w. Eng Rec—Dec. 4, 1909. No. 9893.

Locks.

The Design of the Panama Canal Locks. A critical letter from M. G. Barnes, with reply by Col. H. F. Hodges. 3500 w. Eng News—Dec. 2, 1909. No. 9854.

Mostaganem.

Mostaganem Harbor, Algeria (Le Port de Mostaganem, Algérie.) P. Caufourier. Outlines the history of the port and describes the new harbor works. Ills. Plate. 7000 w. Génie Civil—Nov. 6, 1909. No. 10223 D.

Panama Canal.

Water Supply for the Lock Canal at Panama. Discussion of the paper by Julio F. Sorzano. 8000 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10474 E.

Panoramic View of Pacific Division Looking South. A view covering 12 miles from Culebra Hill to the Pacific Ocean, with brief explanatory note. 400 w. Eng Rec—Dec. 4, 1909. No. 9888.

See also Locks, under WATERWAYS AND HARBORS.

Piers.

Pier 3 of the Boston Terminal of the Boston & Albany R. R. Illustrated description of a pier having a pile substructure, supporting a wooden deck and nearly covered by a steel shed. 3000 w. Eng Rec—Dec. 25, 1909. No. 10439.

The Reinforced Concrete Municipal Pier, Santa Monica, Cal. Edwin Hall Warner. Illustrated description of a pier to carry an outfall pipe and also serve as a pleasure pier. 1000 w. Eng News—Dec. 9, 1909. No. 9982.

Purification.

Results Obtained by State Health Boards. Samuel G. Dixon tells what Pennsylvania is doing to purify the streams of the state; and H. M. Herbert tells what is being accomplished in New Jersey. 2000 w. Munic Jour & Engr—Dec. 8, 1909. No. 9957.

Rock Removal.

Excavating Submerged Rock with a Drill Boat. Illustrates and describes work in the East River, near New York City. 1200 w. Eng Rec—Jan. 8, 1910. No. 10691.

Scarborough.

Recent Improvements in Scarborough Harbor. Illustrates and describes pier extensions and other improvements at this small but important fishing harbor. 1000 w. Engr, Lond—Dec. 31, 1909. No. 10759 A.

Shore Protection.

River Protection Work on the Kansas City Southern Railway, Near Braden, Okla. Discussion by Charles H. Miller of the paper by J. A. Lahmer. 1600 w. Pro Am Soc of Civ Engrs—Dec., 1909. No. 10475 E.

Stream Flow.

Effect of Roughness of Bed on Depth of Water and Distribution of Velocity. E. C. Murphy. Gives results of experiments made in the laboratory of the U. S. Geol. Survey. 1000 w. Eng News—Dec. 30, 1909. No. 10508.

Stream Gauging.

See same title, under MEASUREMENT.

U. S. Waterways.

The Proposed Lakes-to-the-Gulf Deep Waterway. An illustrated account of the proposed fourteen-foot waterway. 2500 w. Sci Am—Dec. 11, 1909. No. 9991.

Transportation on the Mississippi River and Its Tributaries—The Plans of the Mississippi Valley Transportation Co. A

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letter from John L. Mathews, with editorial reply. 3000 w. Eng News—Dec. 2, 1909. No. 9853.

Water Powers.

Water-Power Resources of Texas. James L. Starr. A brief account of the power available and developed. 1500 w. Elec Wld—Dec. 9, 1909. No. 9978.

MISCELLANY.

Caisson-Work Hygiene.

French Government Regulations for Work Under Compressed Air. Translation from the *Ann. des Ponts et Chaussées* of the portions of interest to American compressed air workers. 1000 w. Eng News—Dec. 30, 1909. No. 10507.

Drawing Rack.

A Convenient Rack for Holding Drawings. John H. Gregory. Describes a convenient method of filing drawings so that they may be readily accessible. Ills. 1800 w. Eng Rec—Dec. 25, 1909. No. 10437.

Stone Saws.

Landale's Patent Stone Saw. Illustrated description of the machine, giving a report of test and results. 1800 w. Quarry—Dec., 1909. No. 10040 A.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Phototelegraphy

Telegraphing Pictures. T. Thorne Baker. An illustrated review of progress made by Prof. Arthur Korn in transmitting pictures by electricity. Discussion. 5000 w. Jour Soc of Arts—Nov. 26, 1909. No. 9921 A.

Modern Fac-Simile Telegraphs. Dr. Alfred Gradenwitz. Information concerning the wireless transmission of diagrams, handwriting and photographs by the system of G. J. de Guillén-Garcia. 1200 w. Sci Am Sup—Dec. 25, 1909. No. 10364.

Radio-Telegraphy.

Wireless Telegraphy and Telephony. H. Marchand. A record of recent progress. Diagrams. 4500 w. Sci Am Sup—Dec. 4, 1909. No. 9830.

Wireless Telegraphy. Guglielmo Marconi. The Nobel Prize lecture. Outlines the history of the writer's work in the field of radiotelegraphy, calling attention to some observations still needing explanation. 3000 w. Elec Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10408 A.

Efficiency of Short-Spark Methods of Generating Electrical Oscillations. W. H. Eccles and A. J. Makower. Abstract of paper before the Inst. of Elec. Engrs. Describes apparatus used for measuring the efficiency of the von Lepel discharger, giving report of tests. Ills. 1000 w. Elect'n, Lond—Dec. 17, 1909. No. 10420 A.

Some Quantitative Measurements in Connection with Radiotelegraphy. J. A. Fleming. Abstract of paper read before the Inst. of Elec. Engrs. Describes apparatus for measuring high-frequency resistance, high-frequency currents, condensers, etc. Ills. 2500 w. Elect'n, Lond—Dec. 17, 1909. Serial. 1st part. No. 10419 A.

The Armstrong College Radiotelegraphic Station. Illustrated description of this station, as given by Prof. Henry Stroud in his presidential address before the Newcastle section of the Inst. of Elec. Engrs. 800 w. Engr, Lond—Dec. 17, 1909. No. 10414 A.

Wireless Telegraphy Plant at the Eiffel Tower. Louis Dubois. An illustrated account of the new underground plant being installed at the Eiffel Tower by the French War Department. 1400 w. Elect'n, Lond—Dec. 3, 1909. No. 10053 A.

The "Convector" (Il "Convector"). A. G. Rossi. Illustrated description of this instrument for the detection of Hertzian waves. 2000 w. Industria—Nov. 14, 1909. No. 10242 D.

Radio-Telegraphy at Benadir (La Radiotelegrafia al Benadir). Describes experiments conducted by the Italian Government in East Africa since 1907. Ills. 6500 w. Riv Marit—Nov., 1909. No. 10233 E + F.

See also Phototelegraphy, under COMMUNICATION.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Telautograph.

Transmission of Writing by Machinery. Illustrated description of the telautograph and its action. 4000 w. Am Mach—Vol. 32. No. 51. No. 10344.

Telegraph Lines.

Discussion on "Telegraph and Telephone Systems as Affected by Alternating-Current Lines." Discussion at New York, Oct. 8, 1909. 15500 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9808 F.

Telegraphy.

Mercadier's System of Telegraphy. Describes this system in which vibratory currents are used and, as receivers, telephones tuned to respond to one particular note, so that a number of messages can be sent simultaneously on the same line. 3000 w. Elect'n, Lond—Dec. 17, 1909. No. 10421 A.

Telephone Exchanges.

Automanual Telephone Exchange at Ashtabula Harbor, Ohio. Illustrated detailed description. 3000 w. Elec Rev, N Y—Dec. 4, 1909. No. 9871.

The New Windsor Telephone Exchange, Victoria. Illustrated description of a new installation modelled on the most modern American system. 4000 w. Aust Min Stand—Oct. 27, 1909. No. 9922 B.

Telephone Lines.

The Loading of Telephone Cable Circuits. A. W. Martin. Read before the Inst. of P. O. Elec. Engrs. A mathematical discussion 1200 w Elec Rev, Lond—Dec 10, 1909. Serial. 1st part. No. 10175 A.

Telephone Line Protection from High-Tension Transmission Lines. R. W. Krass. Briefly discusses electromagnetic induction, electrostatic induction, and insulation. 1000 w. Sib Jour of Engng—Dec., 1909. No. 10142 C.

Homogeneous Telephone Lines (Les Lignes téléphoniques homogènes). M. Devaux-Charbonnel. An attempt to reduce complicated transmission problems to that of a simple sinusoidal current. Ills. 5600 w. Bul Soc Int d Elecns—Nov., 1909. No. 10215 F.

Telephony.

Development of the Telephone Industry. L. E. Wilson. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. A review of its development in Manchester particularly. 3500 w. Elec Engr, Lond—Nov. 26, 1909. No. 9927 A.

DISTRIBUTION.

Fuses.

Single and Stranded Low-Tension Fuses. William Tolme Maccall. Abstract of paper read before the Leeds Sec. of Inst. of Elec. Engrs. A report of experiments on fuses, discussing results. 1800 w. Elec Engr, Lond—Nov. 26, 1909. No. 9926 A.

A New System of Electric Fuses (Ein neues System elektrischer Schmelzsicherungen und seine Entstehung). Detailed description of the "Diazed" System. Ills. 3000 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10375 D.

Insulation Faults.

Locating Insulation Faults in Electric Circuits. W. T. Ryan. Explains simple methods covering most cases which arise in ordinary practice. 1000 w. Power—Dec. 14, 1909. No. 10046.

Permutator.

The Rouge-Faget Permutator. F. C. Zanzig. Illustrated description of this machine for changing alternating to direct current, with operating characteristics of a 9 k. w. machine. 2500 w. Elec Rev, N Y—Dec. 4, 1909. No. 9870.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Methods of Drive for Alternators. J. E. Latta. A discussion confined to 60-cycle alternators. 1500 w. Elec Wld—Dec. 2, 1909. No. 9844.

Stator Windings in Alternators (Statorwicklungen schnellaufender. Dreh- und Wechselstrommaschinen). Jacques Büchi. Discusses developments in stator winding design since the introduction of high-speed turbine driving. Ills. 4500 w. Elektrotech u Maschinenbau—Nov. 14, 1909. No. 10377 D.

Damping in the Parallel Operation of Three-Phase Dynamos (Die Stärke der Dämpfung bei parallel geschalteten Drehstrommaschinen). Fritz Emde. Mathematical demonstration of the method of calculating the damping effect. 2200 w. Elektrotech u Maschinenbau—Nov. 21, 1909. No. 10378 D.

The Electric Railway between Villefranche-de-Conflans and Bourg-Madame (Chemin de Fer électrique de Villefranche-de-Conflans à Bourg-Madame). E. Pacoret. Describes particularly the double-current generators employed. Ills. 2500 w. Tech Mod—Nov., 1909. No. 10220 D.

Armatures.

Vector Diagrams of Polyphase Windings. M. V. Ayres. Discusses the care of an armature provided with six slots per pole, considering two sub-types. 2200 w. Elec Wld—Dec. 23, 1909. No. 10361.

Drying.

Drying Out Small Direct Current Machines. R. H. Fenkhausen. Instructions for satisfactory drying of a machine that has been submerged. 1400 w. Power—Dec. 21, 1909. No. 10305.

Field Magnets.

A New Field-Magnet System. J. W. Burleigh. Illustrated description, with facts related. 1000 w. Elec Rev, Lond—Nov. 26, 1909. No. 9929 A.

Flux Distribution.

The Experimental Derivation of Curves of Flux Distribution (Ueber die experimentelle Aufnahme von Feldkurven). Reinhold Rüdenberg. Mathematical discussion of methods of plotting curves of flux-distribution in the air-gap of dynamos. Ills. 2000 w. Elektrotech u Maschinenbau—Nov. 7, 1909. No. 10376 D.

Heating.

Permissible Temperatures in Dynamos and Methods of Determination (Températures admissibles dans les Machines dynamos. Procédés de Détermination, d'après les Travaux de la première Section du Comité). M. M. Brunswick and Boucherot. An exhaustive discussion based on investigations by a Committee of the Soc. Int. des Electriciens, the Engineering Standards Committee, etc. Ills. 21000 w.

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Bul Soc Int d Elecns—Nov., 1909. No. 10216 F.

Induction Motors.

The Determination of Circle Coefficient of the Induction Motor. H. M. Hobart. Describes the author's empirical method of estimating, giving tables and curves. 1800 w. Elec Rev, N Y—Dec. 4, 1909. No. 9869.

Factors Affecting the Design of Self-Excited, Single-Phase, Shunt Induction Motors. Val. V. Fynn. The present installment deals with the no-load conditions of a motor of the type having a commutator short-circuited in line with, and in electrical space-quadrature with the primary magnetism. Diagrams. 1500 w. Elec Wld—Dec. 9, 1909. No. 9979.

ELECTRO-CHEMISTRY.

Calcium Carbide.

Carbide and Acetylene and Their Applications (Karbid und Azetylen und deren technische Verwendung). Adolf Fraenkel. Describes the manufacture of carbide in the electric furnace, various industrial applications of acetylene, etc. Ills. 4500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 5, 1909. No. 10283 D.

Cells.

Dry Cells. Two papers before the Am. Elec.-Chem. Soc. One by F. H. Loveridge, with report of dry cell tests; the other by Prof. C. F. Burgess and Carl Hambuechen, with some characteristics of dry cells. 3500 w. Elec-Chem & Met Ind—Dec., 1909. No. 9974 C.

Some of the Laws Concerning Voltaic Cells. Edward H. Landis. Discusses some of the difficulties which have arisen in endeavoring to understand the fundamental phenomena of voltaic cells, and their solution. 6500 w. Jour Fr Inst—Dec., 1909. No. 10135 D.

A Study of the Leclanché Cell (Untersuchungen über das Leclanchéelement). Ernst Friederich. An exhaustive discussion of its theory, construction, operation, etc. Serial. 1st part. 2700 w. Elektrochem Zeitschr—Nov., 1909. No. 10249 D.

Electric Furnaces.

Electrode Losses in Electric Furnaces. Abstracts of four papers read before the Am. Elec.-Chem. Soc. by Carl Hering, C. A. Hansen, and Dr. E. F. Roeber. 6500 w. Elec-Chem & Met Ind—Dec., 1909. No. 9972 C.

Electrodes.

The Manufacture of Electric-Furnace Electrodes (Fabrication des Electrodes pour Fours électriques). Brief description of methods. 1700 w. L'Elecn—Nov. 27, 1909. No. 10213 D.

Electrolytes.

Practical Conductance of Electrolytes. Abstract of a paper by Prof. Joseph W. Richards and Walter S. Landis, discussing the actual conductance of the electrolyte in electrolytic refining tanks. 1000 w. Elec-Chem & Met Ind—Dec., 1909. No. 9973 C.

Electro-Metallurgy.

See Boron, under MINING AND METALLURGY, MINOR MINERALS.

Electroplating.

Production of the Verde-Antique Finish Direct Upon Soft Metal Novelties. Explains this method of electroplating and the theory of the process. 1000 w. Brass Wld—Dec., 1909. No. 10133.

Silundum.

Silundum. Abstract of a paper by Prof. S. A. Tucker, H. F. Kudlich, and E. M. Heumann on the preparation of silundum. 600 w. Elec-Chem & Met Ind—Dec., 1909. No. 9971 C.

ELECTRO-PHYSICS.

Electromagnets.

The Mechanics of Magnetic Phenomena and the Application of the Science of Mechanics to the Design and Construction of Electromagnets (Die Mechanik der magnetischen Erscheinungen und die Anwendung der Bewegungslehre auf die Konstruktion und Berechnung der Elektromagnete). Herr Zacharias. Ills. 6000 w. Glasers Ann—Nov. 15, 1909. No. 10289 D.

The Electromagnet and its Industrial Applications (L'Electro-aimant et ses Applications industrielles). Henri Bureau. A brief theoretical discussion, and an outline of its use for magnetic chucks, couplings, towing devices, brakes, etc. Ills. 4500 w. Tech Mod—Nov., 1909. No. 10218 D.

Induction Coils.

On the Insulation of Inductive Coils. Albert Campbell and J. L. Eckersley. Mathematical. 1200 w. Elect'n, Lond—Dec. 10, 1909. No. 10177 A.

Thermoelectric Properties.

Note on the Thermoelectric Properties of Tantalum and Tungsten. W. W. Coblentz. Observations on the thermoelectric behavior of tungsten and tantalum. 400 w. Bul Bureau of Standards—Oct., 1909. No. 10331 N.

GENERATING STATIONS.

Accumulators.

The Application of Storage Batteries to the Regulation of Fluctuating Loads. E. B. Walker. An explanation of various booster systems. Diagrams. 1700 w. Can Elec News—Dec., 1909. Serial. 1st part. No. 9812.

Central Stations.

Gas-Producer Central Station at Aberdeen, South Dakota. Illustrated description of a producer-gas plant in operation for nine months. 2000 w. Elec Wld—Dec. 30, 1909. No. 10503.

An Oil Engine Auxiliary Power Station. J. W. Himmelsbach. Illustrated description of a plant installed by the Pitts-

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field, Mass., Electric Co. 700 w. Power—Dec. 28, 1909. No. 10464.

Generating Station of the Home Electric Light & Steam Heating Company at Tyrone, Pa. Illustrated detailed description of a new station. 2000 w. Elec Wld—Dec. 2, 1909. No. 9841.

Power Improvements of the New Jersey & Pennsylvania Traction Company. Explains the conditions when the roads of the company were combined, and the improvements introduced. Ills. 2000 w. Elec Ry Jour—Dec. 4, 1909. No. 9857.

The New Electric Plant of the Orleans Railway at Tours (La nouvelle Usine électrique de la Compagnie du Chemin de Fer d'Orléans, à Tours). Illustrated description of a large station driven by gas power. 2500 w. Génie Civil—Nov. 13, 1909. No. 10224 D.

See also Central Plants, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Economies.

See Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING; and Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Hydro-Electric.

Comments on Development and Operation of Hydroelectric Plants. Henry L. Doherty. Discusses features deserving careful consideration. 8500 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9807 F.

Generating and Transmitting Equipments of the Tokyo Electric Light Company. Brief illustrated description of this important hydroelectric development. 600 w. Elec Wld—Dec. 16, 1909. No. 10125.

Madison River Hydroelectric Development. Illustrated description of a development in Montana. 1700 w. Elec Wld—Dec. 23, 1909. No. 10359.

The Hydroelectric Development and Auxiliary Steam Plant at Lansing, Michigan. Illustrates and describes the system of the Michigan Power Company. 2500 w. Elec Rev, N Y—Dec. 25, 1909. No. 10459.

Norwegian 250,000 h. p. Hydroelectric Development. Einar A. Brofos. Brief illustrated description of the Rjukan plants, designed for furnishing power for the nitrate plants. Also editorial. 2200 w. Elec Wld—Dec. 9, 1909. No. 9976.

The Ackersand Power Station at Visp (Die Wasserkraftanlage Ackersand bei Visp der "A.-G. Elektrizitätswerk Lonza"). Illustrated description of this Swiss plant. Serial. 1st part. 2000 w. Schweiz Bau—Nov. 6, 1909. No. 10269 B.

Isolated Plants.

Centralized Light, Heat, and Power Service in a Large Automobile Works. Illustrates and describes the power plant of Thomas B. Jeffrey & Co., Kenosha, Wis. 2500 w. Elec Rev, N Y—Dec. 18, 1909. No. 10151.

Power Contracts.

Engineering Aspects of Large Electric Power Contracts. Howard S. Knowlton. The second of two articles discussing the relation between the power company and the consumer. 3500 w. Engineering Magazine—Jan., 1910. No. 10492 B.

Protective Devices.

Protection to Station Apparatus. Max H. Collbohm. Proposes a method of station wiring believed to serve well where protection is sought by adding inductance to the circuit. 1000 w. Elec Wld—Dec. 2, 1909. No. 9845.

Switchboards.

Concrete Switchboard Structures. L. B. Chubbuck. Gives illustrated descriptions of recent installations of this type of switchboard structure and the methods of construction. 1200 w. Elec Jour—Dec., 1909. No. 10078.

LIGHTING.

Illumination.

Industrial Lighting (L'Eclairage industriel). A Berthier. An exhaustive treatise on modern light sources and methods of illumination. Ills. 250000 w. Tech Mod—Nov., 1909 (Supplement). No. 10221 N.

Incandescent Lamps.

The Present Aspect of Electric Lighting. H. W. Handcock and A. H. Dykes. Reviews the changes brought about by the extensive adoption of metal filament lamps, and discusses methods of charging. 3000 w. Inst of Elec Engrs—Nov., 1909. No. 9925 N.

Research on Metallic Filament Lamps. F. H. R. Lavender. Abstract of paper before the Birmingham Sec. of the Inst. of Elec. Engrs. An account of an investigation of the conditions of working as regards voltage efficiency and percentage drop in candlepower. 1500 w. Elect'n, Lond—Dec. 3, 1909. No. 10052 A.

Metal Filament Lamps: Their Possible Beneficial Effects on Supply Undertakings. G. Wilkinson and R. McComb. Read before Leeds Sec. of the Inst. of Elec. Engrs. Explains conditions at Harrogate and how the lamps were introduced. 2500 w. Elect'n, Lond—Dec. 17, 1909. No. 10422 A.

Tungsten Illumination. Arthur J. Sweet. Tables and information in regard to a standard line of light units and their use. 2500 w. Elec Jour—Dec., 1909. No. 10081.

The Tungsten Lamp and Its Relations to Central Stations. George Merrill. Aims to show the effect of the tungsten lamp and its later developments upon commercial interests. 4500 w. Cent Sta—Dec., 1909. No. 10036.

We supply copies of these articles. See page 809.

Photometry.

The Methods of Comparing Our Various Sources of Artificial Light. W. E. Barrows, Jr. Discusses mainly the problems of determining the photometrical basis of those comparisons involving the values of the candle power. 2500 w. Elec Rev, N Y—Dec. 11, 1909. No. 10018.

On the Use of the Flicker Photometer for Differently Colored Lights. H Morris-Airey. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Experimental investigation. 900 w. Elect'n, Lond—Dec. 17, 1909. No. 10423 A.

A New Method of Measuring Light Efficiency. C. C. Hutchins. Explains a method found to be as accurate and more simple than the methods hitherto used. 1000 w. Am Jour of Sci—Dec., 1909. No. 9810 D.

MEASUREMENT.

Dynamo Testing.

Shop Testing of Direct and Alternating-Current Machinery. J. W. Rogers. Read before the Rugby Engng. Soc. Gives an outline of the tests carried out by manufacturers and methods used. 2500 w. Mech Engr—Dec. 3, 1909. Serial. 1st part. No. 10056 A.

E. M. F. Waves.

An Approximate Experimental Method for the Analysis of E. M. F. Waves. P. G. Agnew. Describes experiments undertaken to determine whether it is possible to get an approximate value of the first and second harmonics present in an E. M. F. wave by means of ordinary portable instruments and calibrated condensers. 2500 w. Bul Bureau of Standards—Oct., 1909. No. 10330 N.

Instruments.

Compounded Voltmeters giving the Tension at the End of Feeders (Voltmètres compoundés donnant la Tension à l'Extrémité des Feeders). M. Aliamet. Describes a new Chauvin and Arnoux instrument. Ills. 2000 w. L'Elecn—Nov. 6, 1909. No. 10210 D.

Magnetic Induction.

The Determination of the Magnetic Induction in Straight Bars. Describes a method of making precision magnetic measurements in use at the Bureau of Standards, and also investigations made during the development of the method. Ills. 13000 w. Bul Bureau of Standards—Oct., 1909. No. 10329 N.

Meters.

A Rational Method of Installing Service Meters. H. W. Young. Illustrates and describes an installation and testing system now in successful use. 1200 w. Elec Rev. N Y—Dec. 11, 1909. No. 10017.

The Use of Iron in Dynamometer Wattmeters. Charles V. Drysdale. Discusses the effect of hysteresis, or core loss in iron, and refers to the design of ironclad wattmeters and tests. Ills. 1800 w. Elect'n, Lond—Dec. 10, 1909. No. 10178 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Transformer Testing.

Commercial Tests on Transformers. C. L. Gulley. Explains methods of testing in use today by large manufacturing companies. Ills. 3000 w. Ap Sci—Dec., 1909. No. 10469 C.

TRANSMISSION.

Conduits.

Underground Electric Construction. S. J. Lisberger. Read before the Pacific Coast Gas Assn. Describes a method of laying out and operating an underground electric system for distributing light and power. 3500 w. Am Gas Lgt Jour—Dec. 20, 1909. No. 10164.

Methods and Costs of Underground Circuit Construction. Clarence Mayer. A comparison of methods and costs of constructing conduits for electrical transmission lines. Ills. 3000 w. Elec Rev, N Y—Dec. 11, 1909. No. 10015.

Design.

The Calculation of Transmission Lines. A. J. Soper. Explains a new method by the use of tables, illustrating their use by examples. 2500 w. Can Elec News—Dec., 1909. No. 9811.

Long Distance Transmission on Overhead Lines. Prof. E. W. Marchant and E. A. Watson. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses what has been accomplished and technical considerations involved. 5500 w. Elec Engr, Lond—Dec. 3, 1909. Serial. 1st part. No. 10050 A.

Transformers.

The Determination of the Ratio of Transformation and of the Phase Relations in Tranformers. E. B. Rosa and M. G. Lloyd. Explains the methods of measurement of these quantities in use at the Bureau of Standards. 5500 w. Bul Bureau of Standards—Oct. 1909. No. 10328 N.

Underground.

Underground Distribution for Small Cities and Towns. J. Franz. Describes a system that has given satisfactory service for twelve years. Ills. 6000 w. Elec Wld—Dec. 2, 1909. No. 9842.

Voltage Losses.

Calculation of Voltage Drop in an Unbalanced, Three-Phase, Four-Wire System (Calcul des Chutes de Tension dans un Système triphasé à quatre Fils, non équilibré). M. Scoumanne. Mathematical. Ills. 8200 w. Soc Belge d'Elecns—Nov., 1909. No. 10200 E.

An Investigation of the Losses in an Urban Network of Isolated Conductors (Recherche des Pertes sur un Réseau ur-

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bain à plusieurs Conducteurs isolés). A. Combemale. Mathematical demonstration of the method of calculation. Ills. 2000 w. L'Elecn—Nov. 20, 1909. No. 10212 D.

MISCELLANY.

Agriculture.

Electricity in Agriculture in the Summer of 1909 (Weitere Mitteilungen über Elektrokultur vom Sommer 1909). Max Breslauer. Reviews results obtained in the experiments at the Agricultural Institute of the University of Halle-a.-Salle. Ills. 1800 w. Elektrochem Zeitschr—Nov., 1909. No. 10250 D.

Exhibitions.

The Physical Society's Exhibition of Scientific Apparatus. Illustrates and describes some of the electrical, optical, and other exhibits shown. 4000 w. Engng—Dec. 17, 1909. Serial. 1st part. No. 10410 A.

Germany.

Notes on Methods and Practice in the German Electrical Industry. L. J. Lepine and A. R. Stelling. Abstract of paper before the Inst. of Elec. Engrs. Considers the methods of cheap production which render the Germans such serious competitors. 4500 w. Elect'n, Lond—Dec. 10, 1909. No. 10176 A.

Methods and Practice in the German Electrical Industry. L. J. Lepine and A. R. Stelling. Abstract of paper read before the Inst. of Elec. Engrs. Information in regard to internal and external organization, works' systems, machinery, etc. 6000 w. Elec Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10409 A.

INDUSTRIAL ECONOMY.

Accountancy.

The Relation Between Accountancy and Economics. James Edward Le Rossignol. Shows that a knowledge of economics is of value to accountants, and a knowledge of accounts of equal value to economists. 2500 w. Jour of Acc—Dec., 1909. No. 10308 C.

Accounting.

Depreciation. H. W. Wilmot. A discussion of points brought out in Herbert C. Stockwell's paper. 4000 w. Jour of Acc—Dec., 1909. No. 10310 C.

Depreciation, Renewal, and Replacement Accounts. Herbert C. Stockwell. A discussion of the legal requirements, theories, and practical difficulties. 5500 w. Jour of Acc—Dec., 1909. Serial. 1st part. No. 10309 C.

Apprenticeship.

Training of Apprentices on the Grand Trunk Ry. An account of the technical training given. 2000 w. Ry & Engng Rev—Dec. 18, 1909. No. 10199.

Cost Systems.

A Successful Foundry Cost System. J. P. Golden. Describes a system devised to give a ready means of reference and comparison and to lower costs. 2000 w. Am Found Assn—May, 1909. No. 10481 N.

See also same title, under STREET AND ELECTRIC RAILWAYS.

Education.

The University of Leeds. C. Alfred Smith. Especially describes the engineering equipment and illustrates the departments for special work. 2500 w. Engng—Nov. 26, 1909. Serial. 1st part. No. 9941 A.

What Should an Engineer Know of Law. Courtenay De Kalb. Address before the Students' Mining Assn., Univ. of California. Discusses the need of acquaintance with legal principles, and the advantage of special knowledge to mining engineers. 3500 w. Cal Jour of Tech—Dec., 1909. No. 10335.

Recent Developments and Present Tendencies in Technical Education. F. E. Turneaure. From presidential address before the Soc. for the Pro. of Engng. Ed. Reviews past development and present conditions, the requirements of modern engineering, and important changes indicated for the future. 6500 w. Wis Engr—Dec., 1909. No. 10322 D.

Technical Education in Germany (L'Organisation syndicale et Technique en Allemagne). E. Leduc. Report of an investigation to determine the causes of Germany's industrial progress, referring particularly to technical and industrial education. Ills. 41000 w. Bul Soc d'Encour—Oct., 1909. No. 10205 G.

Engineering.

Engineering Responsibility. Presidential address delivered before the American Soc. for Testing Materials, on June 29, by Charles B. Dudley. 5000 w. Pro Am Inst of Elec Engrs—Dec., 1909. No. 9806 F.

Filing Systems.

Requirements of Engineering Files and Indexes. Herman K. Higgins. Parts of a paper read before the Boston Soc. of Civ. Engrs. Outlines the system found satisfactory by the author. 6000 w. Eng News—Dec. 30, 1909. No. 10509.

Industrial Accidents.

Compensation for Accidents. F. W. Ramsey. Explains the Cleveland Foundry Co.'s plans for prevention and relief. 2000 w. Ir Age—Dec. 23, 1909. No. 10358.

We supply copies of these articles. See page 809.

Industrial Insurance.

Old-Age Pensions (Les Retraites ouvrières). Maurice Bellom. An examination of the system in the mining industry in Belgium and of its applicability to conditions in France. 4000 w. Génie Civil—Nov. 20, 1909. No. 10229 D.

The new German Labor-Insurance Legislation (Ueber die neue Reichsversicherungsordnung). Herr Bitta. A review and discussion of the new regulations co-ordinating labor-insurance systems throughout the nation. 7700 w. Stahl u Eisen—Nov. 24, 1909. No. 10255 D.

Inventories.

A Verification and Treatment of Inventories in Audits and Examinations of Manufacturing and Trading Concerns. William R. Mackenzie. Discusses the principles and safest form of procedure to ascertain whether the valuation is a fair one. 3000 w. Jour of Acc—Dec., 1909. No. 10311 C.

Management.

The Problem of the Minor Executive. H. Keith Trask. Discusses the difficulty in finding properly trained subordinate officers for the great industries. 2500 w. Engineering Magazine—Jan., 1910. No. 10486 B.

Organisation by Production Factors. A. Hamilton Church. This fourth article of a series considers buildings, heating and ventilation, stores, and organisation. 5000 w. Engineering Magazine—Jan., 1910. No. 10491 B.

Natural Resources.

Conservation and Some Difficulties. Horace V. Winchell. A criticism of the present action in regard to location of mining claims, taking of homesteads, and sale of coal lands. 1200 w. Min & Sci Pr—Dec. 18, 1909. No. 10456.

Railways and Conservation of Resources. M. V. Richards. Address before the Am. Inst. of Archts. On the work being done by the United States government. 3500 w. Mfrs' Rec—Dec. 23, 1909. No. 10342.

Profit Sharing.

Profit Sharing, Benefits, Pensions. George W. Perkins. Read before the Nat. Civic Fed. An explanation of the underlying principle of the International Harvester Company's plans. 2500 w. Ir Age—Dec. 2, 1909. No. 9815.

Wage Systems.

The Science of Management Engineering. Halbert P. Gillette. Read before the Am. Soc. of Engng. Contractors. A discussion of the unit to be used in paying for work done, and the application of the bonus system. 3500 w. Engng-Con—Dec. 15, 1909. No. 10106.

MARINE AND NAVAL ENGINEERING.

Battleships.

U. S. Battleship Delaware. R. T. Hall. Description of the machinery and report of official trials. Ills. 15700 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10094 H.

United States Battleships Delaware and North Dakota. Illustration and brief description, with report of official trials. 1700 w. Int Marine Engng—Dec., 1909. No. 9898 C.

Cruisers.

The New Scout Cruisers. Illustrates the Gloucester and the Newcastle, the latest Britsh cruisers of the City class, giving information relating to them. 1400 w. Engng—Dec. 3, 1909. No. 10066 A.

Distilling Apparatus.

The Forbes Distiller, Its Principle of Operation, Description and Object. Abridged from a description by the inventor. Ills. 2500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10093 H.

Test of Evaporator. Results and comments from a report of test made with Bureau of Steam Engineering Standard Evaporator and Distillers at the U. S. Experimental Station. Ills. 3500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No 10092 H.

Electric Power.

Benzine-Electric Marine Propulsion (Der benzin-elektrische Propellerantrieb von Wasserfahrzeugen). R. Deetjen. Describes the system and its application in motor boats. Ills. 2000 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10299 D.

Ferry Steamers.

The Ferry Steamer Guanabacoa. Illustrations and descriptions of a double-ended ferry steamer built in England, for Cuba. 800 w. Engr, Lond—Dec. 17, 1909. No. 10415 A.

Naval Architecture.

The German Naval Architects. A report of papers read at the recent meeting of the Schiffbautechnische Gesellschaft, in Chalottenburg. 2200 w. Engr, Lond—Nov. 26, 1909. Serial. 1st part. No. 9945 A.

Naval Organization.

Sanity in Naval Organization. An editorial discussion of Secretary Meyer's new plans for the U. S. Navy Department 3000 w. Engineering Magazine—Jan., 1910. No. 10485 B.

Propellers.

A New Theory of the Screw Propeller. Illustrated account of investigations made

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by Prof. Oswald Flamm. 1600 w. Sci Am —Dec. 25, 1909. No. 10362.

The Utilization of Results of Tests on Propeller Models (Die Verwertung der Versuchsergebñisse mit Modellpropellern). Herr Rothe. Shows the application of the results of various model-basin experiments to actual practice. Ills. 3500 w. Schiffbau—Nov. 25, 1909. No. 10267 D.

Rudders.

The Design of Ships' Rudders. R. J. Grimshaw. An illustrated discussion of the area, form and dimensions. 1500 w. Cassier's Mag—Dec., 1909. No. 9797 B.

The Development of Experimental Methods of Determining Rudder Pressure (Beitrag zur Entwicklung der experimentellen Bestimmung der Rudermomente bezw. Ruderdrücke). Herr Praetorius. Outlines the methods now employed and gives the fundamental formulae. 3000 w. Schiffbau—Nov. 10, 1909. No. 10266 D.

Shipbuilding.

Presidential Address of Charles Pullar Hogg. Brief review of developments of the last 100 years, and reference to future problems. 5000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Oct. 26, 1909. No. 10096 N.

Ship Design.

Approximate Determination of the Deflection of Ships (Ueberschlägliche Berechnung der Durchbiegung von Schiffen). Alfred Schmidt. Gives simple formulae for rough calculations. 3000 w. Schiffbau —Nov. 10, 1909. No. 10265 D.

Ship Resistance.

The Influence of the Depth of Water on the Resistance and Speed of High-Speed Torpedo Craft. Gives a report of observations and experiments, especially the work of Major Rota of the Royal Italian navy. 2000 w. Int Marine Engng—Jan., 1910. No. 10598 C.

Steam Boilers.

The Normand Boilers of the Scout Cruiser Chester. A. F. H. Yates. Illustrated detailed description of the water tube boilers installed. 3000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10086 H.

The Treatment of Marine Boilers on Long Voyages. H. Ruck-Keene. Read before the Inst. of Marine Engrs. Directions for the proper care of marine boilers. 1500 w. Int Marine Engng—Jan., 1910. No. 10595 C.

Steam Engines.

The Design of Reversing Engines. Edward M. Bragg. Shows types, explaining their design. 1500 w. Int Marine Engng—Dec., 1909. Serial. 1st part. No. 9899 C.

The Effect of Superheat on the Economy of a Marine Engine as Determined by Tests on the Steam Yacht Idalia. John Halligan, Jr. A report of tests made. Ills. 1000 w. Jour Am Soc of Nav Engrs —Nov., 1909. No. 10095 H.

Steamships.

The Contributions of the Stevens Family to the Development of Steam Navigation. W. A. Shoudy. Reviews the achievements of Col. John Stevens and his sons, Robert L. and Edwin A. Ills. 7800 w. Stevens Ind—Oct., 1909. No. 10476 D.

The Monitoria. Arthur H. Haver. Illustrated description of a cargo steamer with two longitudinal projections along the outside of the ship which increases the breadth, gives buoyancy, and other advantages. 1000 w. Int Marine Engng—Dec., 1909. No. 9901 C.

The Sea Performances of the S. S. Monitoria. Arthur H. Haver. A single-deck cargo steamer having two longitudinal corrugations along the outside of the hull, stating advantages claimed. Ills. 2500 w. Marine Rev—Dec., 1906. No. 10039.

The New Steamship Wilhelmina. Illustrated description of a steel steamship being built for service between San Francisco and the Hawaiian Islands. 2500 w. Int Marine Engng—Dec., 1909. No. 9902 C.

The Lancashire and Yorkshire Railway Company's Turbine Steamers. Illustrated detailed description of these steel vessels. 1000 w. Engng—Dec. 3, 1909. No. 10065 A.

Twin-Screw Steamer for Submarine Mine Service. Harry L. Fuller and V. R. Marsden. Illustrated description of the steamer "Gen. E. O. C. Ord." 2000 w. Int Marine Engng—Jan., 1910. No. 10599 C.

Steam Turbines.

The Design and Performance of Curtis Marine Turbines. A. P. Chalkley. Brief description of the main features of this turbine, with report of trials. Ills. 1200 w. Engng—Dec. 3, 1909. No. 10063 A.

Upkeep of the Parsons Marine Steam Turbines of the S. S. Chester. A. F. H. Yates. Additional notes on an examination made. 4000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10090 H.

Submarines.

Life-Saving Devices in Submarine Boats. Information from a recent book entitled "A Diving Manual," issued by Siebe, Gorman & Co., Ltd., concerning appliances for saving the lives of men who may sink with a submarine boat when she founders. Ills. 1200 w. Engr, Lond—Dec. 10, 1909. No. 10196 A.

New Swedish and Danish Submersibles. Robert G. Skerrett. Illustrates and describes the Swedish Hvalen and the Danish Dykkeren. 1000 w. Int Marine Engng —Dec., 1909. No. 9900 C.

The Development of the Submarine (Entwicklung der Unterseeboote). Herr Paulus. A general discussion of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10384 D.

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MECHANICAL ENGINEERING.

AUTOMOBILES.

Anhut.

Glimpse of 1911 in Anhut Car. Illustrated description of the general design and interesting details. 2500 w. Automobile—Dec. 16, 1909. No. 10150.

Armstrong-Whitworth.

The Little 12-14-H. P. Amstrong-Whitworth. Illustrated description of a low-powered 4-cylinder vehicle built of the best materials. 900 w. Auto Jour—Dec. 11, 1909. No. 10170 A.

Arrol-Johnston.

An Original Arrol-Johnston Design. Illustrated description of the 15.9 h. p. model for 1910. 700 w. Auto Jour—Dec. 4, 1909. No. 10048 A.

Bodies.

Some Motor Body Criticisms and Contrasts. Illustrated critical notes. 2000 w. Autocar—Dec. 11, 1909. No. 10172 A.

Brakes.

Pointers on Front Wheel Brakes. Chester S. Ricker and Earle A. Ryder. Urging the study of front wheel brakes, showing their advantages. Ills. 1200 w. Horseless Age—Dec. 22, 1909. No. 10368.

Carburettors.

A Justly Popular Carburettor. Illustrated description of the latest White and Poppe Carburettor and its action. 2500 w. Auto Jour—Dec. 18, 1909. No. 10404 A.

Commercial Vehicles.

Steam Wagons. J. C. Cornock. Discusses only the modern machines, describing types and details. 5000 w. Soc of Engrs—Nov. 27, 1909. No. 10339 N.

Commercial-Vehicle Competition, Versailles, October 15 to November 15, 1909 (Concours de Véhicules automobiles industriels, Versailles, 15 Octobre-15 Novembre 1909). E. Girardault. Describes the cars entered and the results of the competition. Ills. 6000 w. Génie Civil—Nov. 27, 1909. No. 10230 D.

See also Motor Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Couplings.

Commercial-Vehicle Couplings (Lastwagen-Kuppelungen). Ernst Valentin. Detailed description of various types. Ills. Serial. 1st part. 1000 w. Motorwagen—Nov. 20, 1909. No. 10282 D.

Crossley.

Some Constructional Features of the Crossley Cars. An illustrated discussion of the lightness in chassis construction, arched live-axles, tubular frame-members, front-wheel brakes and other features. 1600 w. Auto Jour—Dec. 18, 1909. Serial. 1st part. No. 10403 A.

Electric.

The Immediate Future of the Electric Vehicle. Fred J. Newman. Discusses tires, bearings, batteries, etc. 1500 w. Automobile—Dec. 16, 1909. No. 10149.

Woods' Electric Makes Characteristic Progress. Illustrates and describes improvements in details. 2200 w. Automobile—Dec. 16, 1909. No. 10148.

Some Points on the Care of Vehicle Batteries from a User's Standpoint. H. M. Beck. Explains the nature of a storage battery, the methods employed in charging, etc. 3000 w. Cent Sta—Dec., 1909. No. 10038.

Exhibitions.

The Smithfield Club Show. Illustrates and describes some of the interesting engineering exhibits, such as tractors, ploughing engine, spraying machine, etc. 2500 w. Engr, Lond—Dec. 10, 1909. No. 10195 A.

Franklin.

Franklin in Many Forms. Illustrates and describes the 1910 models. 1800 w. Automobile—Dec. 9, 1909. No. 10003.

Fuels.

The New Composite Fuel, "Rapidia." Describes the method of its distillation. 1200 w. Autocar—Nov. 27, 1909. No. 9923 A.

Gear Boxes.

Gear Box Position. Albert L. Clough. Examines the advantages and disadvantages of the three principal methods of arranging the three elements of the transmission chain. 2000 w. Horseless Age—Dec. 22, 1909. No. 10369.

Herreshoff.

The Herreshoff Car for 1910. Illustrated detailed description of a touring car. 1500 w. Horseless Age—Dec. 22, 1909. No. 10370.

Holsman.

Realm of the High Wheeler. Thomas J. Fay. Illustrated detailed discussion of the Holsman high wheel car. 2500 w. Automobile—Dec. 9, 1909. No. 10004.

Ignition.

Battery Ignition to Date. Illustrated description of the latest Lodge igniter. 1500 w. Auto Jour—Dec. 11, 1909. No. 10171 A.

English Double-Ignition System of Unquestioned Merit. Illustrates and describes the Hall dual-ignition system. 1500 w. Automobile—Dec. 9, 1909. No. 10002.

Lighting.

An Inexpensive Home-Made Electric Lighting System. Vincent B. Miner. Illustrated detailed description. 1500 w. Automobile—Dec. 16, 1909. No. 10147.

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Maintenance.

Some Pertinent Hints on Adjustment and Care. Stillman Taylor. Discusses details that should not be neglected. 3000 w. Automobile—Dec. 2, 1909. No. 9864.

Marmon.

Pertinent Details of the Marmon Car. Illustrates and describes the Marmon "Thirty-Two" suburban touring car. 2500 w. Automobile—Dec. 2, 1909. No. 9865.

Motor Cooling.

The Dashboard Radiator. An illustrated discussion of the pros and cons, and whether this new type has come to stay. 2500 w. Auto Jour—Dec. 4, 1909. No. 10047 A.

Lowering the Freezing Point of Cooling Water (Die Gefrierpunktserniedrigung des Kühlwassers). L. Meitner. Discusses the effect of the admixture of various materials. 2300 w. Motorwagen—Nov. 20, 1909. No. 10281 D.

Motors.

Improved Engine Practice. Illustrated review of the development of the petrol engine as shown at the Olympia exhibition. 1500 w. Autocar—Nov. 27, 1909. No. 9924 A.

Motor Valves.

Pointers on Valves and Valve Timing. Arthur H. Denison. Discusses gas inertia, timing, clearance, and other details. 2500 w. Automobile—Dec. 16, 1909. No. 10146.

Valve Location. Albert L. Clough. Discusses the advantages and disadvantages of various arrangements of valves in automobile construction. 1200 w. Horseless Age—Dec. 1, 1909. No. 9868.

Mud Guards.

Mud Guards for Motor Omnibuses (Les Pare-Boue pour Autobus). E. Bret. Describes devices fitted to omnibuses in Paris to prevent splashing of mud on pedestrians. Ills. Plate. 7000 w. Génie Civil—Nov. 20, 1909. No. 10227 D.

National.

Technical Features of the National Car. Details of design and construction are illustrated and described. 2500 w. Automobile—Dec. 23, 1909. No. 10461.

Omnibuses.

Results of Operation of the Bavarian Motor Omnibus and Postal Service in 1908 (Betriebsergebnisse der bayerischen Motorpostlinien im Jahre 1908). Herr Pflug. Detailed tabulated data of costs and returns. 5000 w. Zeitschr d Mit Motorwagen Ver—Nov. 15, 1909. No. 10277 D.

Motor Omnibuses in London (Die Londoner Motor-Omnibusse). Herbert Bauer. An exhaustive review of the traffic, costs, returns, etc. Ills. Serial. 1st part. 2800 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10278 D.

Parry.

Prompt Debut of the Parry. Illustrated description of a new car. 1500 w. Automobile—Dec. 2, 1909. No. 9866.

Power Losses.

Extra Losses in Transmission on Rough Roads and Curves. Albert L. Clough. Discusses some energy consuming factors. 2200 w. Horseless Age—Dec. 8, 1909. No. 10019.

Rapairs.

How Covers and Tubes Are Vulcanized. Jay Teel. Illustrated detailed description of the work. 2000 w. Horesless Age—Dec. 8, 1909. No. 10020.

Royal.

The Royal 1910 Model M. Illustrated detailed description of this chassis, upon which various types of bodies are mounted. 4500 w. Horseless Age—Dec. 8, 1909. No. 10021.

Sizaire-Naudin.

An Interesting French Light Car (Ein interessantes französisches Kleinauto). Herr Schwerdtfeger. Detailed description of a Sizaire-Naudin model. Ills. 2500 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10279 D.

Speedometers.

Concerning Tyres and Speedometers. Comments on the results obtained in experimental tests at Brooklands. 1800 w. Auto Jour—Dec. 18, 1909. No. 10405 A.

Springs.

How Springs Neutralize Shock. Information from a pamphlet issued by the Maxwell-Briscoe Motor Co., explaining the actions and reactions, and how they are absorbed. Ills. 1500 w. Motor Car Jour—Dec. 18, 1909. No. 10402 A.

Testing.

Individuality Imparted to Automobiles. Illustrated description of the system of testing Rambler automobiles, at Kenosha, Wis. 4000 w. Automobile—Dec. 23, 1909. No. 10460.

Transmission Gears.

Chain Drive versus Shaft Drive. Albert L. Clough. Discusses the advantages and disadvantages of the double chain drive, and of shaft drive. 1800 w. Horseless Age—Dec. 15, 1909. No. 10124.

Irregularities in the Motions of Transmission Members. S. Gerster. Discusses the causes of irregularities due to the arrangement of the transmission members. Ills. 2000 w. Horseless Age—Dec. 15, 1909. No. 10123.

Vibration.

Automobile Vibration and Its Physiologic Effects. Andreé Gonthier. Discusses the physiologic effects produced by the vibrations of the automobile, and the class of ailments benefitted. 1500 w. Automobile—Dec. 9, 1909. No. 10001.

Vulcan.

The 12-H. P. Four-Cylinder Vulcan Car. Brief illustrated description of car with centralized worm drive, mechanical lubri-

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cation, and thermo-syphon cooling. 1000 w. Autocar—Dec. 18, 1909. No. 10418 A.

Warren-Detroit.

The Warren-Detroit. Line drawings and description of a 26-28-h. p. four-cylinder model. 1000 w. Horseless Age—Dec. 22, 1909. No. 10371.

Wheels.

Improvements in Resilient Wheels for Vehicles. Hon. R. Clere Parsons. Brief review of the development of wheels and tires, giving an illustrated detailed description of the "Panflex" wheel and explaining its principle. Discussion. 11500 w. Jour Soc of Arts—Dec. 3, 1909. No. 10041 A.

COMBUSTION MOTORS.

Aeronautic Motors.

Aeroplane Engines. Sidney F. Walker. Considers the requirements of such engines in the present number. 2000 w. Mech Wld—Dec. 3, 1909. Serial. 1st part. No. 10059 A.

Benzine Motors.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Gas Engine Guarantees.

Preliminary Report of the Standardization Committee. 10000 w. Jour Am Soc of Mech Engrs—Dec, 1909. No. 9804 F.

Gas Engines.

The Reciprocating Internal Combustion Engine. Horace Allen. Discusses the advantages and disadvantages. 1500 w. Ind Engng—Dec., 1909. No. 10321.

Gas Engine Construction. Lewis H. Nash. Discusses the gas engine from the mechanical and commercial points of view. 4000 w. Stevens Ind.—Oct., 1909. No. 10477 D.

Titusville Gas Engines. Brief illustrated description of two vertical three-cylinder engines installed in the Elec. Lgt. & Power Co.'s station. 1000 w. Ir Age—Dec. 16, 1909. No. 10107.

Gas and Steam Engines (Moteurs à Gaz et Machines à Vapeur). R. E. Mathot. A comparative study of 500 and 1,000 horsepower units, with costs. 3800 w. Tech Mod—Nov., 1909. No. 10219 D.

See also Pumping Plants, under HYDRAULIC MACHINERY.

Gasoline Engines.

See Oil Engines, under COMBUSTION MOTORS.

Gas Power Plants.

Gas Power Section. Report of Plant Operations Committee. 5500 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9803 F.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

Producer Gas for Engine Fuel. E. A. Allcut. Compares the advantages and disadvantages of different coals, discussing conditions to be met with the fuels used in producer gas plants. 3000 w. Am Mach—Vol. 32. No. 51. No. 10346.

Bituminous Gas Producers with Special Reference to Tests on the Double Zone Type. J. R. Bibbins. Records results of recent achievements with bituminous producers in actual service. Ills. 3000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9801 F.

A Tarless Oil-Gas Producer. A. B. Davis. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Illustrated description of the Darling oil-gas system and report of tests made. 1500 w. Eng News—Dec. 9, 1909. No. 9985.

Producer Gas Plant Practice. Michael Chapman. Read before the Engrs' Club of Toronto. Describes the manufacture of producer gas. Ills. 4000 w. Can Engr—Dec. 10, 1909. No. 10031.

Testing Suction Gas Producers with a Keorting Ejector. C. M. Garland and A. P. Kratz. Describes methods of testing used at the Univ. of Illinois, and gives forms for computation. Ills. 5000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9798 F.

Gas Pumps.

See Pumps, under HYDRAULIC MACHINERY.

Oil Engines.

A New Reversible Marine Oil Engine. Illustrated description of Bolinder's engine and its working. 900 w. Engr, Lond—Dec. 10, 1909. No. 10197 A.

Oil and Gasoline Engines for Contractors' Use. Begins a discussion of the selection and care of such engines, the troubles met in operating and their remedies. 1500 w. Engng-Con—Dec. 8, 1909. Serial. 1st part. No. 10025.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Air Liquifaction.

The Theory of the Hampson Liquefier. Edgar Buckinham. Proving the efficiency of the Hampson process. Mathematical. 6000 w. Bul Bureau of Stand—Oct., 1909. No. 10333 N.

Central Plants.

A New Congressional Heating, Lighting and Power Plant at Washington. George H. Draper. Brief illustrated description of the nearly completed central plant built to serve a group of government buildings. 2500 w. Elec Rev, N Y—Dec. 11, 1909. No. 10016.

Electric Heating.

Electric Heaters. H. M. Phillips. Considers various heating devices, such as gas heaters, steam or hot water and especially the advantages of electric heating appliances. 4500 w. Cassier's Mag—Dec., 1909. No. 9794 B.

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Furnaces.

Making a Warm Air Furnace. An illustrated description of the various manufacturing processes for the erection and inspection of such furnaces. 5500 w. Met Work—Dec. 4, 1909. No. 9872.

Hot-Water Heating.

Comparison of Forced-Circulation Hot-Water, and Vacuum Steam Central Heating Plants. Joseph T. Maguire. Aims to show the superiority of the large hot-water plant. 2200 w. Eng News—Dec. 23, 1909. No. 10350.

Rapid-Circulation Hot-Water Heating on the Barker System in the Old Men's Home, Padua, Italy (Schnellumlaufheizung "System Barker" im Greisenasyl Padua, Italy). Werner Berli. Illustrated description of the installation and its operation. 3300 w. Gesundheits-Ing—Nov. 20, 1909. No. 10294 D.

Heating Water by Steam (Die Dampf-Warmwasserheizung). H. Roose. Discusses the heating of water for heating purposes by steam. Ills. 3000 w. Gesundheits-Ing—Nov. 13, 1909. No. 10292 D.

Liquid Air.

Industrial Oxygen (L'Oxygène industriel). Georges Claude. A brief discussion of the industrial uses of oxygen, the production of liquid air, etc. 2300 w. Rev Gen des Sciences—Nov. 30, 1909. No. 10209 D.

Piping.

Depreciation of Underground Heating Pipes. W. A. Knight. Extract from a paper read at the Nat. Dist. Heat. Assn. Discusses details of conduit construction. 1800 w. Met Work—Dec. 4, 1909. Serial. 1st part. No. 9873.

Refrigeration.

The Centerfreeze System of Ice Manufacture. D. J. Havenstrite. Illustrated description of this system. 1800 w. Ice & Refrig—Dec., 1909. No. 9960 C.

The Cell Block System for Making Raw Water Ice. A. C. Bishop. Illustrates and describes the system, explaining its advantages. 2500 w. Ice & Refrig—Dec., 1909. No. 9961 C.

A Modern Ice Factory in St. Louis. Illustrated general description of buildings and equipment of the ice factory of the Merchants' Ice & Coal Co. 3500 w. Ice & Refrig—Dec., 1909. No. 9959 C.

Refrigeration and Electricity Generating Stations. Sydney F. Walker. Deals particularly with conditions in England, discussing why electricity has not been more generally used for driving refrigeration compressors. Gives information in regard to power required, etc. 3000 w. Elec Wld—Dec. 2, 1909. No. 9843.

Steam Heating.

A High-Pressure Feeder for a Low-Pressure Heating System. William Kent. Describes a method planed to save fuel in a large New England factory. 1200 w. Ind Engng—Dec. 15, 1909. No. 10319.

A Heating Plant of Civil War Times. Illustrated detailed description of a steam heating plant in an old New York residence. 3000 w. Met Work—Dec. 18, 1909. No. 10143.

Heating Plant for a Railway Storehouse. J. Irving Brewer. Describes the storehouse and the steam heating arrangements. 2000 w. Eng Rec—Dec. 18, 1909. No. 10163.

See also Hot-Water Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Franz zur Nedden. First instalment of a critical study showing what particular points must be considered in selecting a high-lift centrifugal pump for any given duty. Diagrams. 3000 w. Engineering Magazine—Jan., 1910. No. 10490 B.

The Rees Roturbo Centrifugal Pump. Illustrated description of a late type in which the problem of varying heads is solved. 2000 w. Elec Rev, Lond—Nov. 26, 1909. No. 9928 A.

The Design of the Rotors of High-Speed Low-Pressure Centrifugal Pumps (Ueber die Ausbildung der Laufräder schnellaufender Niederdruck-Zentrifugalpumpen). P. Riebensahm. A review of the principles of their design and constructive types. Ills. Serial. 1st part. 2600 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1909. No. 10274 D.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Electric Pumping.

Electric Drive of Turbine Pumps. Abstract of a paper by J. E. Fries, read before the Am. Soc. of Swedish Engrs. On the selection of a proper size and proper type of motor to meet different conditions. 2000 w. Mach, N Y—Dec., 1909. No. 9834 C.

Electric Mine Pumps (Pompes électriques d'Epuisement pour les Mines). Describes several installations in European mines. Ills. 2000 w. L'Elecn—Nov. 20, 1909. No. 10211 D.

Intensifiers.

Hydraulic Intensifiers. Norman S. Trustrum. Explains the use and the methods, and gives a detailed study of the design of intensifiers. 2200 w. Prac Engr—Dec. 10, 1909. Serial. 1st part. No. 10181 A.

Penstocks.

A Peculiar Penstock Accident at the Lac Du Bonnet Plant of the Winnipeg Electric Ry. An account of the bursting of a penstock, and of the temporary service, and the repairs. 1500 w. Eng News—Dec. 23, 1909. No. 10356.

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Pumping Plants.

Suction-Gas Pumping Plant at Cambrai, Nord, France. A plant recently constructed for these water-works. 500 w. Engng—Dec. 10, 1909. No. 10191 A.

Pumps.

An Internal-Combustion Pump, and Other Applications of a New Principle. Herbert A. Humphrey. Describes a pump in which the explosive force is exerted directly upon the water, and in which no rotating flywheel, solid piston, connecting-rod, crank, bearings, or glands of any sort are required. Ills. 11200 w. Inst of Mech Engrs—Nov. 19, 1909. No. 9805 N.

Impressions of the Humphrey Pump. A short account of an inspection of the experimental apparatus in its latest form. 2800 w. Engr, Lond—Dec. 10, 1909. No. 10194 A.

Turbine Operation of Piston Pumps (Ueber den Antrieb von Hubkolbenpumpen durch Turbinen). Hans Wettich. An exhaustive theoretical discussion. Ills. Serial. 1st part. 2000 w. Die Turbine—Nov. 5, 1909. No. 10273 D.

The Theory of the Pneumatic Lifting of Liquids (Théorie de l' Aspiration pneumatique des Liquides). L. Jannin. An exhaustive discussion of the effect on pump capacity of the admission of bubbles of air to the suction pipe. Ills. 9500 w. Rev de Mécan—Nov., 1909. No. 10241 E + F.

Pump Tests.

Test of Main Circulating Pump for U. S. S. North Dakota. Extract from report of test made by Commander Emil Theiss. 800 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10091 H.

Turbine Governing.

The Control of the Turbine under Varying Load (Das Verhalten der Turbine bei verschiedener Belastung). Prof. Ludewig. A discussion of Herr Bartl's paper on this subject. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1909. No. 10276 D.

Turbine Plants.

The Gregotti Siphon (Sifoni autolivellatori Gregoti). Illsutrated description of a device for maintaining a constant head in water-power plants. Ills. Serial, 1st part. 2500 w. Industria—Nov. 28, 1909. No. 10244 D.

Turbines.

The Modern Theory of Hydraulic Turbines (La moderna Dottrina dei Motori idraulici). D. Spataro. A mathematical discussion of fundamental turbine principles. Ills. Serial, 1st part. 3500 w. Ann d Soc d Ing e d Arch Ital—Nov. 15, 1909. No. 10234 F.

Turbine Testing.

The Turbine Testing Plant and the Power Plants with Storage Accumulators of the Firm of J. M. Voith (Die Turbinenversuchsanstalten und die Wasserkraftwerke mit Wasserkraftspeicher der Firma J. M. Voith). Fritz Oesterlen. Illustrated detailed description. Serial, 1st part. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10381 D.

MACHINE ELEMENTS AND DESIGN.

Ball-Bearings.

Ball-Bearing Apparatus at Neubabelsberg. Henry Hess. Illustrates and describes the machinery used in the famous laboratory that made the finest investigations of ball bearings ever carried out. 3000 w. Am Mach—Vol. 32. No. 52. No. 10499.

Modern Ball Bearings (Die Geschichte des modernen Kugellagers). P. Brühl. A sketch of ball-bearing theory and a review of developments. Ills. Serial, 1st part. 6500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10383 D.

See also Shafting, under POWER AND TRANSMISSION.

Connecting Rods.

A Study of Connecting Rods (Etude de la Bielle motrice). G. Deladrière. A mathematical study of the stresses in connecting rods. Ills. 2500 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10237 D.

Drop Hammers.

Experiments on a Drop Hammer. Yaekichi Sekigucki. An account of tests carried out to ascertain the effect of a blow of a hammer. Ills. 600 w. Am Mach—Vol. 32. No. 52. No. 10500.

Gears.

Facts Concerning Gear Wheel Teeth. A. Marsden. Diagrams and discussion of important facts relating to gear teeth. 3000 w. Autocar—Dec. 4, 1909. No. 10049 A.

The Melville-Macalpine Steam Turbine Reducing Gear. Illustrated description of this device, taken from stated sources. 3500 w. Ir Age—Dec. 9, 1909. No. 9963.

The Melville and Macalpine Speed Reduction Gear for Marine Steam Turbines. Reprints portions of a pamphlet issued by Mr. George Westinghouse, with remarks and editorial. Ills. 8000 w. Eng News—Dec. 30, 1909. No. 10511.

A Note on the Theory of Gears (Notes sur la Théorie des Engrenages). A. R. Garnier. A mathematical discussion of the fundamental principles in gear design. Ills. Serial. 1st part. 5000 w. Rev de Mécan—Nov., 1909. No. 10240 E + F.

Interchangeable Parts.

Interchangeability. Discusses the limitations and variations of replacement parts. 2000 w. Prac Engr—Nov. 26, 1909. No. 9932 A.

Screw Threads.

Commission on Screw Threads (Commission des Filetages). Maurice Picard. Report on a project for standardizing the threads used in the watch and clock industries. Ills. 4000 w. Bul Soc d'Encour—Oct., 1909. No. 10207 G.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

The Treacherous Nature of Aluminum-Zinc Alloys in Sand Casting. Edwin S. Sperry. Discusses the difficulties in working these alloys. 1200 w. Brass Wld—Dec., 1909. No. 10132.

Assembling.

Assembling a 48-Inch Motor-Driven Planer. Alfred Spangenberg. An illustrated article dealing with the erecting process on the bed. 2500 w. Mach, N Y—Dec., 1909. Serial. 1st part. No. 9838 C.

Boiler Making.

See also Shops, under MACHINE WORKS AND FOUNDRIES.

Boring Mills.

The Colburn New Model Boring and Turning Mills. Illustrated detailed description of a new vertical mill built in five sizes. 2500 w. Ir Age—Dec. 30, 1909. No. 10493.

Brass Founding.

Use of a Flux in Melting "Monet Metal." Explains method of melting. 800 w. Brass Wld—Dec., 1909. No. 10134.

Brass Valve and Injector Mixtures from an Old Memorandum Book. James M. Betton. Describes shop practice in a New England foundry thirty years ago. 2500 w. Foundry—Dec., 1909. No. 9913.

Cam Cutting.

The Rowbottom Cam Cutter. Illustrates and describes a new cam cutter built at Waterbury, Conn. 700 w. Ir Age—Dec. 30, 1909. No. 10494.

Castings.

A Large Japanese Bell Casting; the Largest Perfect Bell in Existence. Illustration and information in regard to a bell cast in Osaka, Japan, in 1902, weighing 348,000 lbs. 700 w. Brass Wld—Dec., 1909. No. 10130.

Cupola Practice.

The Heart of the Foundry, as Seen by the Foundry Engineer. D. S. Hawkins. Discusses the problem of the cupola. 2500 w. Am Found Assn—May, 1909. No. 10478 N.

Discussion on Continuous Melting. George K. Hooper. Discussion on Mr. Sleeth's paper. 2000 w. Am Found Assn—May, 1909. No. 10479 N.

Dies.

Dies and Methods for Making Watch Crowns. George J. Murdock. Illustrated detailed description. 3000 w. Mach, N Y—Dec., 1909. No. 9832 C.

Die Sinking.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Drilling Machines.

The Leland High Speed Sensitive Drill. Illustrated description of a new four-spindle drill press. 1200 w. Ir Age—Dec. 2, 1909. No. 9813.

Foundries.

Some Recollections of Soho Foundry, Its Men and Methods. Charles H. Wall. Ills. 5000 w. Engr, Lond—Dec. 17, 1909. No. 10412 A.

Altoona Foundries, Pennsylvania Railroad. Illustrated detailed description of the new foundries at South Altoona for soft gray iron and wheel work, each of which is housed by itself and quite separate. 6000 w. R R Age Gaz—Dec. 3, 1909. No. 9875.

Foundry Furnaces.

Crucible Steel Casting Practice. Illustrated description of the "Milwaukee" type of melting furnace, used in steel foundries of the west. 1200 w. Foundry—Dec., 1909. No. 9911.

Foundry Laboratories.

The Work of an Iron Foundry Laboratory. George Hailstone. Read before the Coventry Engng. Soc. Discusses the work required, the methods, the importance, etc. Ills. 3500 w. Mech Engr—Nov. 26, 1909. Serial. 1st part. No. 9938 A.

Foundry Materials.

Fluxes and Mould Facings. Walter J. May. Discusses the use of these aids to the production of good castings. 2000 w. Mech Wld—Dec. 3, 1909.. No. 10057 A.

Foundry Practice.

Casting Cannon in Reign of Louis XV. Joseph S. Horner. Illustrates and describes French foundry practice in the 18th century, including core-making, molding, melting and casting. 2500 w. Foundry—Dec., 1909. No. 9914.

Gear Cutting.

Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-Over. Ralph E. Flanders. Illustrates and describes a method which gives better results and a saving in time. 3500 w. Mach, N Y—Dec., 1909. No. 9831 C.

Accurate Setting of the Bevel Gear Cutter. Warren E. Thompson. Deals exclusively with the formed bevel gear rotary cutter, explaining a method of mathematically finding the correct setting of the bevel gear cutter in relation to the axis of the gear. 1500 w. Mach, N Y—Dec., 1909. No. 9833 C.

Grinding.

Grinding Milling Cutters on the Lathe. Arthur F. Kunze. Explains a method that may be used in the absence of a grinder. Ills. 800 w. Am Mach—Vol. 32. No. 50. No. 10111.

Errors in Grinding Tapered Reamers and Milling Cutters. H. A. S. Howarth. Describes methods commonly used, showing the inaccuracy of the first method described, and discussing the errors introduced. Ills. 1500 w. Mach, N Y—Dec., 1909. No. 9839 C.

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Grinding Machines.

Grinding Machines. Illustrates and describes types, aiming to give a general idea of the scope of grinding machines. 8500 w. Engr, Lond—Nov. 26, 1909. Supplement. No. 9044 A.

Jigs.

Jig for Boring a Bearing in the Drill Press. M. E. Dawson. Illustrated description of the jig, and its use, and the tools for finishing. 1200 w. Am Mach—Vol. 32. No. 49. No. 9966.

Lathes.

Lathes for Turbine Work and Shafting. Illustrations, dimensions and short description of a lathe designed for working with high-speed tool-steel. 400 w. Engng—Dec. 10, 1909. No. 10187 A.

Machine Tools.

Notes on the Cost of Operating Machine Tools. A. G. Popcke. An analysis of general and specific charges against electrically driven machine tools. 1500 w. Elec Jour—Dec., 1909. No. 10083.

Metal Spinning.

Methods and Tools Used in Metal Spinning. C. Tuells. An illustrated outline of methods and tools used in spinning for rapid production. 3500 w. Mach, N Y—Dec., 1909. No. 9835 C.

Molding Machines.

An Intricate Machine Pattern Plate. F. W. Hall. Illustrated description of how a pattern for an automatic machine casting was mounted on a roll-over molding machine. 2000 w. Foundry—Dec., 1909. No. 9912.

Patterns.

Patterns for a Helical Tapering Pipe. Drawings and description of method of developing the patterns. 4500 w. Met Work—Dec. 18, 1909. No. 10144.

Pipe Founding.

German Methods in the Manufacture of Cast Iron Pipe. From an article by Gustav Simon, in *Stahl und Eisen*, describing the German method. Ills. 900 w. Ir Age—Dec. 16, 1909. No. 10108.

The Production of Cast-Iron Socket Pipes (Zur Fabrikation gusseiserner Muffenröhren). Gustav Simon. Describes moulds, casting, etc. Ills. 4000 w. Stahl u Eisen—Nov. 3, 1909. No. 10251 D.

Planing Machines.

Four-Cutter Planing and Moulding-Machine. Illustrated description of a machine made in England. 400 w. Engng—Dec. 3, 1909. No. 10064 A.

The Evolution of the Planing Machine, Thomas R. Shaw. An illustrated article reviewing the history of planing machines from 1802. 5500 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9793 B.

Press Tools.

Some Large Sectional Punches and Dies. Illustrates and describes how special press tools are built up in sections. 1200 w. Am Mach—Vol. 32. No. 50. No. 10112.

Automatic Punch and Die Construction. W. J. Kaup. Illustrates and describes tools for performing a combination of operations. 800 w. Am Mach—Vol. 32. No. 51. No. 10345.

Press Tools for Computing-Machine Parts. F. A. Stanley. Illustrates and describes accurate punches and dies for blanking, shaving, piercing, etc. 2200 w. Am Mach—Vol 32. No. 51. No. 10343.

Running-Balance Machine.

A Running Balance Machine. An illustrated description of the Norton machine and its operation. 1200 w. Am Mach—Vol. 32. No. 50. No. 10109.

Screw Machines.

The Lester Automatic Screw Machine. F. A. Stanley. Illustrated description of a new machine showing features of interest. 3000 w. Am Mach—Vol. 32. No. 49. No. 9964.

Shop Appliances.

Tools Used in Making Remington Typewriters. Illustrates and describes special machines, fixtures and attachments. 2500 w. Am Mach—Vol. 32. No. 48. No. 9828.

See also Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Location.

Selecting the Site for a Manufacturing Plant. Oscar E. Perrigo. Discusses the considerations and conditions of importance in the location of the plant and buildings. 4500 w. Ind Engng—Dec., 1909. No. 10320.

Shop Practice.

Shop Kinks. An illustrated collection, gathered by George L. Fowler, from the new shops of the Delaware, Lackawanna & Western, at Scranton. 4500 w. R R Age Gaz—Dec. 3, 1909. No. 9877.

Die Sinking and Shop Practice in the Armstrong Bros. Plant. Ethan Viall. Illustrates and describes methods used in this Chicago plant for the manufacture of small tool specialties. 2000 w. Mach. N Y—Dec., 1909. No. 9837 C.

Manufacturing Automobile Equalizing Gears. Ralph E. Flanders. Illustrates and describes the operations for making a complete differential or equalizing gear for automobile use. 4500 w. Mach, N Y—Dec., 1909. No. 9836 C.

Shops.

A Modern Boiler Shop. E. R. Fish. From a paper read at a joint meeting in St. Louis. Illustrates and describes features of the new plant of the Heine Safety Boiler Co. 3500 w. Ir Age—Dec. 9, 1909. No. 9962.

Central Shop of the Imperial Salt Works at Bleicherode (Die Zentralwerk-

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statt des kgl. Salzwerks zu Bleischerode) Herr Stoll. Illustrated detailed description. 4000 w. Glückauf—Nov. 20, 1909. No. 10261 D.

Type-Making Machines.

Modern Automatic Type-Making Methods. W. J. Kaup. Illustrated detailed description of methods and machines. 2500 w. Am Mach—Vol. 32. No. 50. No. 10113.

Welding.

Fusion Welding with Liquefied Lighting Gas. Alfred Gradenwitz. Information concerning Blau gas-oxygen welding. Ills. 500 w. Compressed Air—Dec., 1909. No. 10100.

The Oxy-Acetylene Welding Process. J. F. Springer. Illustrates and describes the use of the blow-torch in the repair of defective castings. 3500 w. Foundry. Dec., 1909. No. 9915.

Fusion Welding Apparatus and Work. E. F. Lake. Illustrates and describes a portable welding outfit, the multiple generation of oxygen and actylene, hydraulic pressure control, a new design of blowpipe, etc. 1500 w. Am Mach—Vol. 32. No. 49. No. 9967.

Autogenous Welding (Die autogene Schweissung). H. Rinne. Describes processes and gives test results on welded metals. Ills. 3500 w. Stahl u Eisen—Nov. 17, 1909. No. 10254 D.

See also Power Plants, under POWER AND TRANSMISSION.

Wire Drawing.

From Pig Iron to Finished Steel Wire. Illustrates and describes methods followed by the American Steel and Wire Co. 1200 w. Am Mach—Vol. 32. No. 52. No. 10498.

MATERIALS OF CONSTRUCTION.

Alloys.

Patent Situation in the United States Respecting Alloys. G. H. Clamer. An explanation of existing conditions. 4000 w. Am Brass Found's Assn—May 1, 1909. No. 10482 N.

The Tensile Strength of Aluminum-Zinc Alloys. Wilder D. Bancroft. An experimental investigation, with results. 1500 w. Am Brass Found's Assn—May, 1909. No. 10483 N.

The Reducing Alloy Sical. Information of an alloy consisting principally of a mixture of silicon and aluminium with the addition of small quantities of other elements, such as titanium, calcium, and manganese. 400 w. Engr, Lond—Dec. 10, 1909. No. 10198 A.

Modern Materials for Automobile and Motor Construction (Modernes Konstruktions-material für den Automobil- und Motorenbau). Describes the properties of various alloys. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1909. No. 10280 D.

Alloy Steels.

Manganese and Its Effect on Iron and Steel. H. J. Coe. Read before the Staffordshire Ir. & St. Inst. An examination into the history of manganese and its relations to the development of iron metallurgy. 5000 w. Ir Trd Rev—Dec. 2, 1909. No. 9863.

Copper.

The Characteristics of Copper Under Various Conditions. George W. Handscomb. Read before the Inst. of Marine Engrs. Deals with the manipulation of this metal by the copper worker. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10088 H.

Metallography.

Notes on the Structure of a Very Pure Iron-Carbon Alloy. Albert Sauveur. Photomicrographs and description of a pure iron-carbon alloy obtained by melting some electrolytic iron with sugar charcoal in a graphite crucible brasqued with magnesia. 1000 w. Ir Trd Rev—Dec. 16, 1909. No. 10117.

Nomenclature of the Constituents of Iron and Steel (Sur la Nomenclature des Constituents du Fer de l'Acier, et de la Fonte). F. Osmond. A criticism of the nomenclature adopted by the International Association for Testing Materials, with a reply by H. Le Chatelier. 2500 w. Rev de Métal—Nov., 1909. No. 10203 E + F.

Wire Rope.

See Rope Splicing, under MISCELLANY.

MEASUREMENT.

Dynamometers.

A Transmission and Recording Dynamometer. James W. Hughes. Illustrated description of a machine which automatically makes a record of torque in inch-pounds and number of revolutions from which h. p. is easily computed. 2000 w. Am Mach—Vol. 32. No. 48. No. 9829.

A Transmission and Recording Dynamometer. James W. Hughes. Illustrates and describes an invention of the author, which automatically records the torque in inch-pounds and number of revolutions from which h. p. is computed. 1800 w. Power—Dec. 18, 1909. No. 10304.

A Recording Dynamometer for Shock Tests (Dynamètre enregistreur de Chocs). L. Schlüssel. Illustrated description of the instrument and method of use. 2000 w. Génie Civil—Nov. 13, 1909. No. 10226 D.

Gas Meters.

An Electric Gas Meter. Carl C. Thomas. Illustrated description of a meter designed for measuring the rate of flow of gas, air or steam. 3500 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9800 F.

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Hardness.

The Scleroscope in Automobile Work. Illustrates and describes the mechanism of the instrument, giving testing problems, and standards adopted. 2500 w. Am Mach—Vol. 32. No. 49. Serial. 1st part. No. 9965.

Laboratories.

The Work of the Reichsanstalt in 1908. A brief account based upon the official report. Ills. 2500 w. Engng—Dec. 3, 1909. Serial. 1st part. No. 10061 A.

Lubricant Testing.

The Choice of a Lubricant. David L. Gallup. Illustrated description of the Kingsbury oil-testing machine and its use, with suggestions for selecting oils. 2500 w. Horesless Age—Dec. 22, 1909. No. 10366.

Micrometers.

An Electro Micrometer. George J. Murdock. Illustrated description of a tool for accurate measurements, general testing and comparison. 1800 w. Am Mach—Vol. 32. No. 50. No. 10110.

Planimeters.

What Is the Zero Circle of a Planimeter? C. J. Mason and W. G. Hawley. An explanation of what it is and how to apply it. 700 w. Power—Dec. 28, 1909. No. 10463.

Pyrometers.

The General Principles of Operation of Industrial Types of Electric Pyrometers. C. H. Wilson. An explanation of how physical phenomena are employed for the measurement of heat. 2000 w. Am Brass Found's Assn—May, 1909. No. 10484 N.

The Estimation of the Temperature of Copper by Means of Optical Pyrometers. G. K. Burgess. Experiments made to determine the thermal properties at high temperatures. 2000 w. Bul Bureau of Standards—Oct., 1909. No. 10332 N.

Steam Meters.

Continuous Records of Steam Consumption of Engines. Wiliam H. Booth. Illustrates and describes the Lea recorders and their behavior. 3000 w. Train & Ry Wld—Dec. 2, 1909. No. 10101 B.

See also Gas Meters, under MEASUREMENT.

Tachometers.

The Davison Revolution Indicator and Regulator. W. B. Tardy. Illustrated description of the device and its operation. 1500 w. Jour Am Soc of Nav Engrs—Nov., 1909. No. 10087 H.

Testing Machines.

Recent English Testing Machines (Neuere Englische Materialprüfmaschinen). Max Kurrein. Describes a number of types of machines for various purposes. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1909. No. 10386 D.

Testing Materials.

The Experimental Method in the Science and Practice of Construction (Il Metodo sperimentale nelle Scienze e nella Pratica delle Costruzioni). Giulio Revere. A discussion of the importance of testing materials and a review of progress in testing methods. 4500 w. Monit Tech—Nov. 10, 1909. No. 10245 D.

Testing Methods.

Report of the Fifth Congress of the International Association for Testing Materials (Compte rendu des Travaux du cinquième Congrès de l'Association Internationale pour l'Essai des Matériaux). M. Révillon. An abstract of the papers and discussions. 10500 w. Rev de Métal—Nov., 1909. No. 10202 E + F.

Some Reflections on the Testing of Materials (Quelques Réflexions sur l'Essai des Matériaux). Henry Le Chatelier. A general discussion of the subject, with a criticism by M. G. Charpy. 3000 w. Rev de Métal—Nov., 1909. No. 10204 E + F.

On Stress Distribution During Tension Tests. C. Alfred M. Smith. Facts concerning stress distribution in direct-loaded tests. Diagrams. 1500 w. Engng—Dec. 10, 1909. No. 10190 A.

The Testing of Metals by Alternating Stresses (L'Essai des Métaux aux Efforts alternatifs). Henry Le Chatelier. Read before the Int. Assn. for Testing Mats. Ills. 2000 w. Rev de Métal—Nov., 1909. No. 10201 E +F.

POWER AND TRANSMISSION.

Air Compressors.

Converting an Air Compressor. Plan and description of method used in converting a steam engine into an air compressor. 1500 w. Mech Wld—Nov. 26, 1909. No. 9939 A.

Compressed Air.

Compressed Air Calculation Short Cuts. Snowden B. Redfield. Gives a chart by which mean effective pressure and horsepower may be determined. 1500 w. Eng & Min Jour—Dec. 11, 1909. No. 10013.

Costs.

Cost of Power for Various Industries. Abstract of a paper by Charles T. Main and F. M. Gunby, before the Boston Soc. of Civ. Engrs. Gives a comparison of costs and methods of saving, with especial reference to textile mills. 1800 w. Eng Rec—Dec. 25, 1909. No. 10435.

A Graphical Method of Determining the Cost of Power (Graphisches Verfahren der Betriebskostenberechnung). Hans Gisi. Gives curves from which power costs under any given set of conditions may be calculated. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1909. No. 10387 D.

Electric Driving.

The Distribution and Application of Electric Power. J. S. Peck. Read before the Manchester Assn. of Engrs. A gen-

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eral description of the systems of generation and distribution, the principles of the machines, and some recent developments in electrical machinery. Ills. 2000 w. Mech Engr—Dec. 17, 1909. Serial. 1st part. No. 10426 A.

Central Station Electrical Motor Service. Walter Stuart Kelley. Outlines some of the advantages of central-station service to industrial buildings. 4500 w. Elec Wld—Dec. 2, 1909. No. 9846.

Multi-Speed Drive by Induction Motors. H. C. Specht. Illustrates and describes examples. 2500 w. Elec Jour—Dec., 1909. No. 10080.

Application of Variable Speed Three-Phase Motors to the Driving of Machines for Printing Textiles. Gives a comparative study between the methods of speed regulation by pole commutation and by other methods and of the results obtained. 4500 w. Elect'n, Lond—Nov. 26, 1909. No. 9930 A.

See also Machine Tools, under MACHINE WORKS AND FOUNDRIES; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubricants.

See Lubricant Testing, under MEASUREMENT.

Mechanical Plants.

Domestic Engineering in the Belnord, New York's Greatest Apartment Building. Lucy Cleveland. Illustrated detailed description of this fine building in N. Y. City, and the mechanical plant that furnishes heat, light, ventilation, refrigeration, hot and cold water, etc. 7000 w. Dom Engng—Dec. 25, 1909. No. 10444.

Power Plants.

The Power Plant of the Harvard Medical School. Illustrated detailed description of a central plant to serve a group of detached buildings in a great many applications. 3500 w. Elec Wld—Dec. 10, 1909. No. 10126.

Installing a Power Plant Under Difficulties. Warren O. Rogers. Gives an illustrated account of difficulties encountered in transporting apparatus five miles through mud; also describes a method of welding a broken flywheel. 2000 w. Power—Dec. 7, 1909. No. 9916.

Shafting.

Detection of Defects in Shafting and in Its Alinement after Erection. Charles C. Klein. Drawings and directions for determining the nature of the defect and its location. 2000 w. Power—Dec. 14, 1909. No. 10044.

Line Shaft Efficiency, Mechanical and Economic. Henry Hess. Illustrates and describes a series of comparative tests made to demonstrate the value of ball bearnings, discussing results. 3000 w. Jour Am Soc of Mech Engrs—Dec., 1909. No. 9799 F.

STEAM ENGINEERING.

Boiler Corrosion.

What Corrosion Did to a Boiler, and How the Boiler Was Repaired. Illustrated description of a case of internal corrosion and the method of repair. 1200 w. Boiler Maker—Dec., 1909. No. 10030.

Boiler Design.

On the Number of Courses in a Boiler Shell. An illustrated discussion of how many parts there should be, showing the three-course shell. 2000 w. Locomotive—Oct., 1909. No. 9874.

Boiler Economy.

Preventable Losses by the Municipal Boiler Plants of New York City. Extracts from the report of W. N. Polakov and W. A. Russell concerning investigations of preventable losses in coal consumption. 2500 w. Eng News—Dec. 23, 1909. No. 10353.

Boiler Efficiency.

Real Relation of CO_2 to Chimney Losses. Joseph W. Hays. Shows that the test for percentage of carbonic acid in flue gases is reliable as a measure of boiler furnace efficiency. 3500 w. Power—Dec. 7, 1909. No. 9920.

See also Fuels, under STEAM ENGINEERING.

Boiler Joints.

Cracks in Longitudinal Boiler Seams. S. F. Jetter. Suggested explanation of the formation of cracks in longitudinal boiler joints. Ills. 1500 w. Power—Dec. 21, 1909. No. 10303.

Boiler Management.

Boiler Room Rules. Gives rules for prolonging the life of boilers and preventing casualties. 2500 w. Cent Sta—Dec., 1909. No. 10037.

Economy in the Use of Fuel (Wirtschaftlichkeit und Kontrolle von Feuerungsbetrieben). Ludwig Dietz. A general discussion of the principles of economical and efficient boiler management. Serial. 1st part. 5500 w. Gesundheits-Ing—Nov. 27, 1909. No. 10295 D.

See also Fuels, under STEAM ENGINEERING.

Boilers.

A New Type of Water Tube Boiler. T. H. McGraw, Jr. An illustrated discussion of a new vertical water tube boiler and the advantages claimed. 3500 w. Pro Engrs' Soc of W Penn—Nov., 1909. No. 10075 D.

Boiler Theory.

Chemistry of the Steam Boiler. Dr. E. E. Basch, in *Zeit für angewandte Chemie*. Explains the science of steam generation. 4000 w. Sci Am Sup—Dec. 11, 1909. No. 9994.

Boiler Tubes.

Defective Boiler Tubes and Their Renewal. M. Kennett. Discusses causes for failure of fire or water tubes, giving directions for renewal. Ills. 5500 w. Power—Dec. 7, 1909. No. 9918.

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Boiler Waters.

Paterson's Pressure Filters. Illustrated description of large filters designed for removing large quantities of suspended matter from water used as a boiler-feed supply. 600 w. Engng—Dec. 10, 1909. No. 10189 A.

Condensers.

The Steam Condensing Plant. J. A. McLay. Illustrates and describes the Leblanc rotary dry air pump and condensers, explaining its efficiency. 1500 w. Elec Jour—Dec. 1909. No. 10082.

The Function of the Air and Circulating Pumps. Walter Smith. Inst. of Marine Engrs. Ritchie award prize essay. Describes the pumps and their action. Ills. 2800 w. Can Engr—Dec. 17, 1909. No. 10145.

Condensation in Steam-Engine Practice (La Condensacion en las Maquinas de Vapor). Modesto M. de Cordova. A theoretical study of condensation and a review of condenser practice. Ills. Serial. 1st part. 2500 w. Energia Elec—Nov. 25, 1909. No. 10248 D.

Economizers.

The Care and Working of Economizers. Calls attention to neglect that will cause risk and danger in fuel economizers. 2500 w. Elec Rev, Lond—Dec. 3, 1909. No. 10051 A.

Engine Cylinders.

Reducing Steam Consumption in Steam Engines. Describes a method devised by R. A. Dawbarn for heating the parts of an engine cylinder with which the steam comes into contact. 1600 w. Prac Engr—Dec. 10, 1909. No. 10180 A.

Engine Design.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Economy.

Receiver Pressure. E. H. Lockwood. Shows how the dry steam used by a compound engine can be calculated, and how its amount is affected by change in the receiver pressure. 1800 w. Power—Dec. 21, 1909. No. 10302.

Engine Performance.

Simple Curves Instead of Tables. F. R. Low. Explains the Willans straight-line law for total steam consumption in proof that engine performance is better shown by curves than by figures. 1800 w. Power—Dec. 7, 1909. No. 9917.

Engines.

A Murray Laboratory Engine. Illustrated description of a cross compound Corliss engine built for the University of Nebraska. 900 w. Ir Age—Dec. 23, 1909. No. 10357.

Entropy.

A Note on Entropy (Note sur l'Entropie). M. Dwelshauvers-Dery. A brief mathematical paper correcting some errors in a former paper by the same author. Ills. 1500 w. Rev de Mécan—Nov., 1909. No. 10239 E + F.

Feed-Water Heaters.

Piping Open Feed Water Heaters. Illustrated descriptions of applications of steam-stack heaters, with suggestions for eliminating unnecessary piping. 1200 w. Power—Dec. 21, 1909. No. 10301.

Fuels.

Making Steam with Mixed Fuel. Arthur S. Mann. Considers practical methods for economical operation in the fire-room. Ills. 2500 w. Engineering Magazine—Jan., 1910. No. 10487 B.

Comparative Tests of Run-of-Mine and Briquetted Coal on the Torpedo-Boat Biddle. Walter T. Ray and Henry Kreisinger. An account of steaming tests made alongside a dock to determine whether briquetted coal has advantages over raw coal. Ills. 13500 w. U S Geo Serv—Bul. 403. No. 10076 N.

The Influence of the Volatile Constituents of Fuels on the Efficiency of Internally Fired Boilers (Ueber den Einfluss der flüchtigen Bestandteile, fester Brennstoffe auf den Wirkungsgrad von Kesselanlagen mit Innenfeuerung) E. J. Constam and P. Schläpfer. An elaborate discussion based on test results. Ills. Serial. 1st part. 6500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1909. No. 10382 D.

Gas Fuel Appliances. W. K. Eavenson. Read before the Empire State Gas & Elec. Assn. Illustrates and describes appliances for the use of gas for industrial purposes. 4500 w. Pro Age—Dec. 15, 1909. Serial. 1st part. No. 10098.

Burning Natural Gas as a Boiler Fuel. David Moffat Myers. Gives results obtained in actual practice with two types of burner showing the value of natural gas as a fuel. 2000 w. Power—Dec. 7, 1909. No. 9919.

See also Locomotive Fuels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Pipes.

Steam Piping. R. H. Vennell. Discusses general practice and manufacture of high-pressure pipes. Ills. 900 w. Prac Engr—Nov. 26, 1909. No. 9931 A.

Some Useful Points on Piping. W. H. Wakeman. Compares correct and incorrect practices and gives instructions for the best location of pipes. Ills. 2000 w. Power—Dec. 21, 1909. No. 10307.

Superheating.

Symposium on the Effect of Superheated Steam on Cast Iron and Steel. Three papers: Cast Iron Fittings for Superheated Steam, by Prof. Ira N. Hollis; The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron and Steel, by Prof. Edward F. Miller; and Cast Iron Valves and Fittings for Superheated Steam, by

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Arthur S. Mann. Ills. 5500 w. Jour Am Soc of Mach Engrs—Dec., 1909. No. 9802 F.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Turbine Design.

A Method of Calculating Steam-Turbines. Mr. Rateau. Tran. from a paper read before the Assn. Tech. Maritime, Paris. Gives calculations of internal and external losses as applied to a mixed turbine. Ills. 4000 w. Engng—Dec. 10, 1909. No. 10193 A.

Steam-Turbine Design (Verfahren zur Berechnung von Dampfturbinen). A. Rateau. Gives data of the methods of measuring efficiency in the first part. Ills. Serial. 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1909. No. 10275 D.

The Caluculation of Wheel Discs (Berechnung von Radscheiben). Huldreich Keller. A mathematical discussion, with application of the formulae to the design of steam-turbine rotors. Ills. 4000 w. Schweiz Bau—Nov. 27, 1909. No. 10272 B.

Turbines.

The Interborough Low-Pressure Turbine. Fred L. Johnson. Illustrated description of the 5000-kw. three-stage Curtis turbine and Manhattan engine of equal capacity in the 59th St. station, New York, and report of tests. 2000 w. Power—Dec. 14, 1909. No. 10043.

Vacuum Pumps.

Rotative Dry Vacuum Pumps. Fred. H. Moody. Describes this class of pump and its uses, operation, etc. Ills. 2000 w. Ap Sci—Dec., 1909. No. 10470 C.

Valves.

Automatic Valve-Locking Gear. Describes an apparatus, invented by J. A. Fletcher, explaining its action. Ills. 500 w. Engng—Dec. 10, 1909. No. 10188 A.

Frictionless Valves for Water, Steam and Gas Pipe Lines (Obturateurs sans Frottement pour Canalisation d'Eau, Vapeur ou Gaz). J. Vinsonneau. Describes a number of types and illustrates the principles of their design. Ills. 2000 w. Rev Indus—Nov. 6, 1909. No. 10222 D.

TRANSPORTING AND CONVEYING.

Ashes Handling.

See Coal Handling, under TRANSPORTING AND CONVEYING.

Cableways.

The Cableway and Its Uses. Sterling H. Bunnell. Illustrates and describes types of conveying appliances. 4000 w. Cassier's Mag—Dec., 1909. No. 9795 B.

Aerial Ropeway at Monte Video. Illustrates and describes a ropeway for conveying coal to the electric-power station from lighters moored alongside a dolphin built off-shore. 1000 w. Engng—Nov. 26, 1909. No. 9942 A.

Coal Handling.

Some Notes on Coal and Ashes Handling Equipment. David Gaehr. Read at meeting of Ohio Soc. of Mech., Elec. & Steam Engrs. Comparing systems and showing possible saving and advantages of such installations. 4000 w. Ir Trd Rev—Dec. 16, 1909. No. 10118.

Cranes.

Cranes and Hoisting Machinery. J. F. Springer. Illustrated descriptions of recent developments in crane construction, both afloat and ashore. 3000 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9792 B.

Recent Developments in Electrically Operated Hoisting Appliances (Neuere elektrisch betriebene Hebezeuge). L. Riefstahl. The first part discusses the powering of travelling cranes. Ills. Serial. 1st part. 3000 w. Elektrotech u Maschinenbau—Nov. 28, 1909. No. 10379 D.

Elevators.

A Common Type of Electric Elevator Machine. William Baxter, Jr. Illustrated description of the construction and operation of one of the early Otis designs, with details of the stop-motion mechanism and magnetic safety attachment. 1800 w. Power—Dec. 21, 1909. No. 10306.

Freight Handling.

Mechanical Transshipment of Railway and Water-Borne Freight. H. McL. Harding. An illustrated discussion of methods with special reference to the Port of New York. General discussion. 2000 w. Pro N Y RR Club—Nov. 19, 1909. No. 10072.

MISCELLANY.

Aeronautics.

Aerial Navigation (La Navigazione aerea). G. Arturo Crocco. Mathematical paper on theoretical aerodynamics. Serial. 1st part. 3500 w. Industria—Nov. 14, 1909. No. 10235 D.

The Aerodynamic Institute at Koutchino (L'Institut aérodynamique de Koutchino). L. Lecornu. Describes a laboratory in Russia for the investigation of aerodynamic problems. 2700 w. Tech Mod—Nov., 1909. No. 10217 D.

Present-Day Aerodynamic Researches. Paul Minet. Trans. from *L'Automobile*. Illustrates and describes Rateau's experiments. 2500 w. Sci Am Sup—Dec. 25, 1909. No. 10363.

The Design and Construction of Aeroplanes. J. P. Chittenden and L. H. Robinson. Read before the Rugby Engng. Soc. Reviews the results of their own and others' experiments. Ills. 5000 w. Mech Engr—Dec. 24, 1909. No. 10630 A.

Apparatus for Testing Aeroplane Models. C. E. Larard and R. O. Boswall. Illustrates and describes an apparatus, designed by the authors, for quantitative work, with planes of different forms and aspect ratios,

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capable of being set at different angles. 3000 w. Engng—Dec. 10, 1909. No. 10186 A.

Motors for Aerial Navigation. J. S. Critchey. Abstract of a paper read before the Inst. of Auto. Engrs. States the requirements of such motors and discusses types. Ills. 2500 w. Prac Engr—Nov. 26, 1909. Serial. 1st part. No. 9933 A.

Aëroplanes of Canadian Aërodrome Company. L. P. Alford. Illustrated description of two large successful machines built. 2000 w. Am Mach—Vol. 32. No. 49. No. 9968.

The Development of the Aeroplane. Henry Harrison Suplee. Reviews the principles upon which the machines are based, giving an account of some of the most successful recent devices. Ills. 3500 w. Cassier's Mag—Dec., 1909. Serial. 1st part. No. 9796 B.

The Frankfort Aeronautical Exhibition. J. O. Newman. An illustrated review of the principal exhibits, showing the latest developments in aerial flight and warfare. 3000 w Cassier's Mag—Dec., 1909. No. 9791 B.

Agricultural Machinery.

American Harvesting Machinery—The Birth and Growth of a Vast Industry. Illustrated review of the development of this class of machinery. 2800 w. Sci Am —Dec. 11 1909. No. 9992.

Auxetophone.

The Auxetophone or Music Magnifier, Compressed Air the Agent. Illustrated description of an invention of Hon. C. A. Parsons, for increasing the volume and intensity of tone. 500 w. Compressed Air —Dec., 1909. No. 10099.

Guns.

The Engineering of Ordnance. A. Trevor Dawson. Deals briefly with the manufacture of steel for guns, their construction, the influence of explosive compounds, breech mechanisms, mounting, etc. Ills. 7500 w. Jour Am Soc of Nav Engrs—Nov. 1909. No. 10089 H.

Gun Sights.

Sights for Small Arms and Machine-Guns. Deals with a new sighting system invented by Captain Antonio Calichiopulo. Ills. 1200 w. Engng. Dec. 3, 1909. No. 10062 A.

Rope Splicing.

Splicing Wire and Other Ropes. J. Watt. Illustrated description of methods used. 1500 w. Am Mach—Vol. 32. No. 49. No. 9969.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mines of North America. Frederick L. Hoffman. Gives statistics showing that 2600 were killed in 1908, and about 20000 in the last decade. 3000 w. Eng & Min Jour—Dec. 25, 1909. No. 10445.

Coal Mine Accidents and Their Prevention. J. A. Holmes. Address before the Nat. Civic Fed. Summarizes the economic conditions of coal mining in the United States, discussing the remedies. 700 w. Eng News—Dec. 9, 1909. No. 9981.

Briquetting.

See Peat, under COAL AND COKE; Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING; and Locomotive Fuels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Canada.

The Production of Coal, Coke, and Peat in Canada During the Calendar Years 1907 and 1908. 8000 w. Canada Dept of Mines—No. 45. No. 10139 N.

Explosions.

The Cherry Mine Disaster. A preliminary account of the accident in the mine of the St. Paul Coal Co., at Cherry, Ill. 3000 w. Mines & Min—Dec., 1909. No. 9884 C.

The Story of the St. Paul Mine Fire. Floyd W. Parsons. Illustrated detailed account of the disaster at Cherry, Ill. 4000 w. Eng & Min Jour—Dec. 4, 1909. No. 9887.

A Natal Colliery Explosion and Underground Fires in Fiery Mines. William Taylor Heslop. Abstract of paper read before the N. of England Inst. of Min. & Mech. Engrs. Describes the explosions, and gives information related. 2500 w. Ir & Coal Trds Rev—Dec. 7, 1909. No. 10430 A.

Explosives.

A Primer on Explosives for Coal Mines. Charles E. Munroe and Clarence Hall. Aims to tell what explosives are and how they should be handled to prevent accidents. Ills. 18500 w. U S Geol Surv—Bul. 423. No. 10416 N.

Discussion of Explosives in Coal Mines. Frank F. Morris. Information in regard to experiments which are leading to the production of an explosive that will not flame, yet will not shatter the coal Ills. 6500 w. Eng & Min Jour—Dec. 18, 1909. No. 10155.

Mine Dust.

Suppressing Coal Dust at the Dourges Collieries. M. Bonneau. Trans. from *Bul. de la Soc. de l'Ind. Min.* Briefly considers the sources of dust, describing the meth-

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ods adopted for the prevention of explosions. Ills. 2000 w. Ir & Coal Trds Rev—Nov. 26, 1909. No. 9946 A.

Mine Fires.

See Explosions, under COAL AND COKE.

Mine Gas.

A New Appliance for the Determination of Firedamp. Trans. from the *Bul. Soc. de l'Ind. Min.* Prof. E. Hauser describes a new appliance in which he has avoided the use of india rubber. Ills. 1000 w. Col Guard—Dec. 10, 1909. No. 10185 A.

Testing for Carbon Monoxide in Connection with Fires and Explosions in Mines. A lecture by Drs. J. S. Haldane and C. Gordon Douglas. Explains the test that seems to them the most practical for use in mines. 4000 w. Col Guard—Dec. 17, 1909. No. 10427 A.

Peat.

Heseltine Process for the Briquetting of Peat. Norman B. Beasley. Brief illustrated description of this process. 1000 w. Min Wld—Dec. 11, 1909. No. 10033.

Rescue Apparatus.

The Works of Messrs. Siebe, Gorman and Co., Limited. Illustrates and describes briefly the making of rescue apparatus for underground use. 1500 w. Col Guard—Nov. 26, 1909. No. 9940 A.

A Historical Note on Rescue and Fire-Protection Appliances for Coal Mines (Beiträge zur Geschichte des bergmännischen Rettungs- und Feuerschutzwesens). Herr Hagemann. A review of early developments in this field. Ills. 4200 w. Glückauf—Nov. 20, 1909. No. 10262 D.

System for Protecting the Lives of Miners. William J. Armbruster. Explains a proposed plan for furnishing means of escape and for protecting lives of miners in case of disaster. 2200 w. Min Wld—Dec. 4, 1909. No. 9904.

Safety Lamps.

Mine Safety Lamps (Die Grubensicherheitslampe). Wolfgang Kummer. Describes recent developments in this type of apparatus. Ills. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Nov. 13, 1909. No. 10285 D.

Scotland.

The Index-Beds in the Carboniferous Limestone Series of Scotland. R. W. Dron. Abstract of paper read at meeting of the Min. Inst. of Scotland. Describes the geology of these coal deposits. 1500 w. Ir & Coal Trds Rev—Dec. 17, 1909. No. 10429 A.

Spitzbergen.

Bituminuous Deposits of Spitzbergen and the Barren Isles (Die Steinkohlenvorkommen Spitzbergens und der Bäreninsel). Herr Freimuth. Detailed description of the coal fields. Ills. 6500 w. Glückauf—Nov. 27, 1909. No. 10263 D.

Texas.

The Coal Resources of West Texas. William B. Phillips. Gives statistics of coal production in Texas since 1883, and information concerning the bituminous deposits, and the transportation facilities. 1500 w. Mfrs Rec—Dec. 9, 1909. No. 9952.

United States.

The Conservation of Coal in the United States. Discussion of the paper of Edward W. Parker. 2000 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10327 F.

Washing.

See Coal Separators, under ORE DRESSING AND CONCENTRATION.

COPPER.

Alaska.

Mining on Prince William Sound, Alaska. Clinton P. McCormick. Illustrated description of this district, its mining industry, the towns, etc. 2200 w. Min Wld—Dec. 18, 1909. No. 10165.

Arizona.

Copper Deposits of Silverbell, Arizona. C. F. Tolman, Jr. Describes the location, geology, ore bodies and other deposits. Ills. 1200 w. Min & Sci Pr—Nov. 27, 1909. No. 9859.

Australia.

West Pilbarra Mining Centres (W. A.). H. P. Woodward. An account of copper mines and gold deposits found in this district 2500 w. Aust Min Stand—Nov. 3, 1909. No. 10168 B.

Blast Furnaces.

Trial Runs with the Garretson Furnace. Clarence C. Semple. Gives results obtained in experiments with this furnace for reducing sulphide copper ores to metallic copper in one operation. 2500 w. Eng & Min Jour—Dec. 25, 1909. No. 10449.

British Columbia.

Mines of the Granby Consolidated, Phoenix, B. C. Roy Hutchins Allen. Data relating to the geology, mining and transport of ore, development, etc. Ills. 2500 w. Eng & Min Jour—Dec. 25, 1909. No. 10447.

Notes on Mother Lode Mine in British Columbia. Roy Hutchins Allen. Describes the geology and mining methods, underhand stoping; average production 8 to 9 tons per day per man employed; total cost below 65c. per ton. Ills. 2000 w. Eng & Min Jour—Dec. 4, 1909. No. 9885.

Dust Flues.

See Smelter Stacks under COPPER.

Mexico.

The Magistral Copper District, Mexico. P. A. Babb. Brief illustrated description. 1400 w. Eng & Min Jour—Dec. 18, 1909. No. 10153.

Refining.

See Electrolytes, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Russia.

Ural Copper Ores and Their Reduction. B. B. Pomerantzieff. Classifies and gives the chemical composition of ores, describing methods of treatment. 2000 w. Min

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Jour—Nov. 27, 1909. Serial. 1st part. No. 9934 A.

Smelter Fumes.

The Smelter Smoke Situation in California. W. D. Egilbert. A review of the controversy between the farmers and mining companies in regard to certain damages caused by smelter fumes. 2000 w. Min Wld—Dec. 4, 1909. No. 9905.

Smelters.

Smelting Plant of the Butte Reduction Works. A. H. Wethey. Illustrated outline of the equipment and operation, with some special features. 1000 w. Eng & Min Jour—Dec. 11, 1909. No. 10012.

The Pacific Smelting and Mining Co.'s Plant. W. B. Budrow. Describes the equipment and operation of this plant in Sonora, Mexico. 2000 w. Min Wld—Dec. 25, 1909. No. 10454.

Smelter Stacks.

The World's Largest Chimney. R. L. Herrick. Illustrated description of a chimney at Great Falls, Mont., giving plan and dimensions of chimney and dust flues, and describing the apparatus for arresting dust. 3000 w. Mines & Min—Dec., 1909. No. 9878 C.

Yukon.

Report on the White Horse Copper Belt, Yukon Territory. R. G. McConnell. Abstract of report issued by the Geological Survey Branch, Dept. of Mines, Ottawa. 5500 w. Can Min Jour—Dec. 1, 1909. Serial. 1st part. No. 9910.

GOLD AND SILVER.

Assaying.

The Determination of Silver and Gold in the Dry Way (Zur Silber- und Goldbestimmung auf trockenem Wege). Rudolf Grund. A discussion of silver losses and a comparison of assaying methods. Ills. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 6, 1909. No. 10258 D.

Australia.

See same title, under COPPER.

Cobalt.

The McKinley-Darragh-Savage Property, Cobalt. Alexander Gray. An account of what has been accomplished under new management. Ills. 1500 w. Min Wld—Dec. 25, 1909. No. 10451.

Cyaniding.

Tests on Acid Regeneration of Cyanide Solutions. R. P. Wheelock. Reports investigations made of the cyanide treatment with the object of decreasing the cyanide consumption. 4000 w. Min & Sci Pr—Dec. 18, 1909. No. 10455.

Graphite—An Obstacle to Good Cyaniding. M. W. von Bernewitz. Suggests method of minimizing the trouble caused by graphite in ores. 1200 w. Min & Sci Pr—Dec. 4, 1909. No. 9999.

Hydraulic Mining.

Hydraulic Mining on the Pacific Coast. Al. H. Martin. Describes properties operating in California and Oregon. 3000 w. Mines & Min—Dec., 1909. No. 9879 C.

See also Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Mexico.

Development at the Esperanza Mine, El Oro, Mexico. W. E. Hindry. Describes development work, timbering, prospecting, and gives costs. 3000 w. Min & Sci Pr—Dec. 18, 1909. No. 10457.

San Ygnacio Mine and Mill, Chihuahua, Mex. Oreste Peragallo. Illustrated article on the geology, deposits, economics and treatment. 2000 w. Eng & Min Jour—Dec. 25, 1909. No. 10448.

Nevada.

The Bullfrog Mining District of Nevada. A. H. Martin. An illustrated description of this goldfield and its development. 2500 w. Min Wld—Dec. 11, 1909. No. 10032.

Placer Mining.

A New Method of Working Stream Beds. H. S. Taylor. An invention relating to placer mining for gold is illustrated and described, and other work, to which it may be applied, is suggested. 600 w. Min Wld—Dec. 11, 1909. No. 10035.

IRON AND STEEL.

Blast-Furnace Slag.

Blue Blast-Furnace Slags (Blaue Eisenhochofenschlacken). August Harpf, Max Langer and Hans Fleissner. A review of the literature of the subject and a report of some investigations by the authors. Serial. 1st part. 4500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 20, 1909. No. 10260 D.

Blowing Engines.

Gas Converter Blowing Engine (Gaskonvertergebläse). P. Schmerse. Describes the construction and performance of a recent installation. Ills. 1600 w. Stahl u Eisen—Nov. 24, 1909. No. 10257 D.

Brazil.

Iron Ore Deposits of Brazil. Orville A. Derby. Abstract of a report prepared for the Int. Geol. Congress to meet in 1910. Information in regard to the geology, ore deposits, quality, etc. 1700 w. Eng & Min Jour—Dec. 25, 1909. No. 10446.

Canada.

The Production of Iron and Steel in Canada During the Calendar Years 1907 and 1908. John McLeish. Statistical review. 8500 w. Canada Dept of Mines—No. 42. No. 10140 N.

Dry-Air Blast.

Improvements in the Dry-Air Blast. Illustrates and describes apparatus for preserving uniformity of temperature in blast. 1400 w. Eng & Min Jour—Dec. 11, 1909. No. 10014.

Electro-Metallurgy.

Report on an Electric Shaft Furnace at Domnarfvet. Eugene Haanel. A report of preliminary experiments carried out in

We supply copies of these articles. See page 809.

Sweden. Ills. 1500 w. Elect'n, Lond—Dec. 10, 1909. No. 10179 A.

Pig-Iron Production in the Electric Shaft Furnace at Domnarfvet, Sweden (Die Roheisenerzeugung im elektrischen Hochofen in Domnarfvet, Schweden). B. Neumann. Describes the plant, process and results. Ills. 7700 w. Stahl u Eisen—Nov. 17, 1909. No. 10253 D.

Electric Smelting with the Girod Furnace. W. Borchers. Describes furnaces in successful operation on a commercial scale in European steel works. 3500 w. Eng & Min Jour—Dec. 4, 1909. No. 9886.

The Girod Furnace and Smelting Plant (Der Girod-Ofen und die elektrischen Schmelzwerke, System Paul Girod). W. Borchers. Detailed description of the works at Ugine, Switzerland. Ills. 3600 w. Stahl u Eisen—Nov. 10, 1909. No. 10252 D.

The Production of Steel in the Electric Furnace (Ueber elektrische Oefen mit besonderer Berücksichtigung der Elektrostahldarstellung). Viktor Engelhardt. A general review of the present state of the metallurgy of iron. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 19, 1909. No. 10284 D.

France.

The Iron Ore Deposits of France, Algeria and Tunis. M. Nicou. Trans. from *Ann. der Mines.* A review of known deposits and their development. 2000 w. Ir & Coal Trds Rev—Nov. 26, 1909. No. 9947 A.

Ingot Compression.

Lees' Apparatus for Casting Fluid-Pressed Steel Ingots. Illustrated description. 1500 w. Mech Engr—Nov. 26, 1909. No. 9937 A.

Ingot Piping.

Piping and Segregation in Steel Ingots. Discussion of the paper of Henry M. Howe. Ills. 3300 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10326 F.

Influence of Top-Lag on the Depth of the Pipe in Steel Ingots. Henry M. Howe. Note in reply to statements by A. A. Stevenson, and supplementary to an earlier paper by the author. 1200 w. Bul Am Inst of Min Engrs—Dec., 1909. No. 10325 F.

Lake Superior.

The Wonderful Iron Mines of Lake Superior—How the Ore Is Mined and Carried in Bulk. Illustrated description of these vast deposits, and the methods of mining and transporting. 2500 w. Sci Am—Dec. 11, 1909. No. 9990.

Open Hearth.

Recent progress in Open Hearth Steel Practice. Bradley Stoughton. Considers important modifications in design and practice, with reference to the attempts to make low-carbon steel, and brief notes on the Duplex process. Ills. 1600 w. Jour Fr Inst—Dec., 1909. No. 10137 D.

Rolling Mills.

Rolling Speed and Annealing. Grant D. Bradshaw. A report of tests showing their effect on soft bar steel. 1200 w. Ir Age—Dec. 2, 1909. No. 9814.

Some Phases of Electric Power in Steel Mills. Charles F. Scott. Read before the Assn. of Ir. & St. Elec. Engrs. Considers briefly the cost of power and of motors, the selection of motors, the power factor, etc. 3300 w. Elec Jour—Dec., 1909. No. 10079.

The Economical Operation of Reversing Rolling Mills. Illustrated description of the Dunlop automatic adiabatic "closed circuit" air transmission system adapted to the transmission of power from a gas engine to an intermittently working reversing rolling-mill engine. 3000 w. Mech Wld—Dec. 3, 1909. No. 10058 A.

Electric Reversing Rolling Mill at the Rheinische Steel Works. G. Mayer, in *Stahl und Eisen.* Illustrates and describes the arrangement for electric driving, which is based on the Ilgner system. 1200 w. Ir & Coal Trds Rev—Dec. 3, 1909. No. 10071 A.

Electric Driving in Rolling Mills (La Commande électrique des Laminoirs). Franz Dupont. Discusses electrical operation of reversing and non-reversing roll trains. 7000 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10236 D.

Steel Making.

The Scientific Evolution of Metallurgy (L'Evolution scientifique de la Métallurgie). Léon Guillet. Refers particularly to the important discoveries in the metallurgy of iron and steel. 3500 w. Bul Sci d l'Assn des Elèves—Nov., 1909. No. 10238 D.

Steel Works.

The Resicza Iron and Steel Works. Describes Austro-Hungary's largest steel producer. 4000 w. Ir Trd Rev—Dec. 16, 1909. No. 10119.

Mechanical Operation of Steel Works (Der maschinelle Betrieb auf Hüttenwerken). E. Riecke. Discusses progress since the development of the large gas engine and the application of electric power to the driving of rolls. 3500 w. Stahl u Eisen—Nov. 24, 1909. No. 10256 D.

Trade.

Iron Trade Conditions in San Francisco. H. Cole Estep. An illustrated account of the progress since the earthquake and fire. 4500 w. Ir Trd Rev—Dec. 16, 1909. No. 10116.

Virginia.

Titaniferous Iron Ores of Virginia and North Carolina. E. A. Schubert. Information in regard to the distribution, discussing their possibilities as an economic factor in the future. 3000 w. Mfrs' Rec—Dec. 23, 1909. No. 10341.

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LEAD AND ZINC.

Australia.

Zeehan Silver-Lead Field (T.). W. H. Twelvetrees and L. K. Ward. Information from the preliminary report of government geologists favoring work at increased depth. 2500 w. Aust Min Stand—Nov. 17, 1909. No. 10406 B.

Lead Assaying.

Electroanalytical Determination of Lead as Peroxide. Henry J. S. Sand. Read before the Faraday Soc. Gives an account of experiments made to determine the behavior of a lead peroxide deposit on drying and to study the effect of varying conditions. 2000 w. Elec Engr, Lond—Dec. 10, 1909. No. 10173 A.

Mexico.

The San Ignacio Mine and Its Dry Mill. Charles A. Dinsmore. The ore is a combination of lead and zinc sulphide, the lead carrying silver. The mill is a dry concentrator. Ills. 1200 w. Min Wld—Dec. 18, 1909. No. 10167.

Virginia.

Lead and Zinc Ores of Virginia. M. M. Caldwell. Abstract of a paper read before the Appalachian Engng. Assn. Describes deposits that have been worked, and others undeveloped. 1800 w. Mines & Min—Dec., 1909. No. 9881 C.

MINOR MINERALS.

Boron.

Boron. Dr. E. Weintraub's paper on an experimental research, with the object of producing pure boron in fused homogeneous form, suitable as material for incandescent lamp filaments. 4500 w. Elec Chem & Met Ind—Dec., 1909. No. 9970 C.

Cement.

Modern Cement Mill Construction. H. G. Barnhurst. A detailed discussion of the design and equipment of modern mills. Ills. 2500 w. Cement Age—Dec., 1909. No. 10314 C.

Diamonds.

The Diamond Fields of Brazil. Hugh Pearson. Brief account of the country, with maps, and a review of the history of diamond mining and description of the districts, methods of working, etc. Short discussion. 3000 w. Jour Soc of Arts—Dec. 17, 1909. No. 10417 A.

Fluorspar.

Fluorspar Grades and Markets. F. Julius Fohs. Gives the classification and information relating to this product. 2000 w. Min & Sci Pr—Nov. 27, 1909. No. 9862.

Granites.

Granites. Gordon Surr. Information concerning their origin, varieties, and associated minerals. 2200 w. Min & Sci Pr—Nov. 27, 1909. No. 9860.

Natural Gas.

See Oil, under MINOR MINERALS.

Oil.

Production of Natural Gas and Petroleum in Canada During the Calendar Years 1907 and 1908. 4000 w. Canada Dept of Mines—No. 46. No. 10138 N.

Ozokerite.

Ozokerite in Utah. H. W. MacFarren. Describes this mineral wax and its metallurgy as developed in Utah. 1200 w. Min & Sci Pr—Dec. 11, 1909. No. 10122.

Turquoise.

History and Mining of Turquoise in Southwest. Fayette A. Jones. An account of the workings in New Mexico. 1500 w. Min Wld—Dec. 25, 1909. No. 10453.

MINING.

Drill Bits.

Design of Bits for Power Drills. Edward R. Judd. Brief discussion of chisel, concave and convex bits, and their action. Ills. 1200 w. Eng & Min Jour—Dec. 18, 1909. No. 10154.

Electric Hoisting.

Electrically Operated Mining Winches (Neuere Grubenhaspel mit elektrischem Antrieb). W. Lohmann. Describes various types of small electric hoists. Ills. 2800 w. Glückauf—Nov. 27, 1909. No. 10264 D.

Electric Power.

The Dangers of Electric Apparatus, and Precautions Necessary to Prevent Accident. A. Meynier. Trans. from *L'Electricien*. Explains the physiological effects of electric currents, and the precautions necessary. 3500 w. Ir & Coal Trds Rev—Dec. 3, 1909. No. 10070 A.

Fans.

Test of a Waddle Fan. G. L. Kerr. Describes the method of conducting the test and of determining the losses due to leakage of air at shaft head, etc. 2500 w. Mines & Min—Dec., 1909. No. 9883 C.

Haulage.

Mechanical Haulage in Mines. Abstract of committee report to the Roy. Com. on Mines as to the causes of accidents. An examination of the systems. Ills. 4500 w. Mech Engr—Dec. 17, 1909. Serial. 1st part. No. 10425 A.

Hoisting.

Brakes for Colliery Winding Engines. Abstract from report of Committee appointed by the Royal Commission on Mines to inquire into causes and means of preventing accidents in pit shafts, etc. Ills. 1500 w. Mech Engr—Nov. 26, 1909. No. 9936 A.

Hoisting Engines.

Winding Engine Design. G. James Wells. Abstract of paper read before the Manchester Assn. of Engrs. On designing a winding engine for a stated duty. 1000 w. Prac Engr—Dec. 3, 1909. Serial. 1st part. No. 10055 A.

Large Mine Hoisting Engines. Warren

O. Rogers. Illustrates and describes designs. 2500 w. Power—Dec. 28, 1909. No. 10462.

Simple Types of Small Hoisting Engines. Warren O. Rogers. Illustrated descriptions of various forms of machines, showing different combinations of engine and boiler and methods of driving. 1000 w. Power—Dec. 21, 1909. No. 10300.

Hydraulic Stripping.

Stripping a Vein by Hydraulicking. A. F. Hughes. Brief illustrated description of a method of uncovering ore, used near Carville, California. 800 w. Min & Sci Pr—Dec. 11, 1909. No. 10121.

Mine Locomotives.

Compressed-Air Locomotive Equipment at the Orlau-Lazy Mines (Die Luftlokomotivanlage des Steinkohlenbergbaues Orlau-Lazy am Neuschachte Lazy, Schlesien). Al. Holan. Illustrated description of the haulage equipment of these coal mines in Silesia. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen —Nov. 13, 1909. No. 10259 D.

Mine Telephones.

The Advantages of a Mine Telephone System. E. O. Munson. Gives plan showing method of wiring a mine for telephones, and explains the advantages. 900 w. Min Wld—Dec. 25, 1909. No. 10452.

Ore Chutes.

The Züblin Ore Chute (Erztaschenauslauf mit Klappenverschluss, Bauart Züblin). F. Züblin. Illustrated description. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1909. No. 10385 D.

Prospecting.

Aid of Vegetation and Animals in Prospecting. Arthur Lakes. Calls attention to surface signs useful in locating ore bodies and mineral products. Ills. 1000 w. Min Wld—Dec. 18, 1909. No. 10166.

Shaft Sinking.

Concrete Shafts Through Quicksand. Frederick W. Adgate. Illustrated account of concrete caissons sunk by the pneumatic and the dredging system to a depth of 113 feet. 3500 w. Mines & Min —Dec., 1909. No. 9882 C.

Sinking the John Shaft at Hamsterley Colliery Through Sand and Gravel by Means of Underhanging Tubbing. John Cummings. Read at meeting of the N. of England Inst. of Min. & Mech. Engrs. Describes this work. 3000 w. Ir & Coal Trds Rev—Dec. 17 1909. No. 10428 A.

Surveying.

Separate Leaf System for Recording Survey Notes. Lee Fraser. Explains in detail the system and discusses its advantages. 800 w. Eng & Min Jour—Dec. 25, 1909. No. 10450.

Timbering.

Cement Stringers for Inclined Shafts. Lee Fraser. Illustrates and describes the permanent construction used in the Michigan copper country. 500 w. Min Wld—Jan. 1, 1910. No. 10532.

Tunnels.

Tunnel Driving in Colorado. H. Foster Bain. Illustrated account of tunnel work in progress in mining districts and for drainage. 3500 w. Min & Sci Pr—Dec. 4, 1909. No. 9997.

Ventilation.

See Fans, under MINING.

ORE DRESSING AND CONCENTRATION.

Coal Separators.

A New Separator for the Removal of Slate from Coal. W. S. Ayres. Reviews briefly the history of anthracite coal preparation, and gives an illustrated description of the author's new separator and report of its operations. 2200. Bul Am Inst of Min Engrs—Dec., 1909. No. 10324 F.

Filtration.

Oliver Continuous Filter. A. H. Martin. Illustration of a slime filter, with brief description. 800 w. Min & Sci Pr—Nov. 27, 1909. No. 9861.

Lead Milling.

See Mexico, under LEAD AND ZINC.

Magnetic Concentration.

The Concentration of Magnetic Iron Ores. N. V. Hansell. Discusses magnetic concentration of low-grade magnetites. Ills. 5000 w. Engineering Magazine —Jan., 1910. No. 10488 B.

Zinc Milling.

Horwood Process for Sulphide Ore. Donald Clark. Describes a process for the separation of zinc sulphide from intermixed sulphides and gangue. 2800 w. Aust Min Stand—Nov. 10 & 17, 1909. Serial. 2 parts. No. 10407 each B.

MISCELLANY.

Alloys.

Note on the Eutectic Alloy of Lead and Tin. L. Parry. Gives the writer's method of determining the composition of the lead-tin eutectic. 1200 w. Min Jour—Dec. 11, 1909. No. 10184 A.

Iron Copper Alloys. Abstract of paper by Prof. Charles F. Burgess and James Aston. An account of experimental investigations. 2000 w. Elec-Chem & Met Ind—Dec., 1909. No. 9975 C.

Jamaica.

See Newfoundland, under MISCELLANY.

Newfoundland.

The Mineral Wealth of the Islands of Newfoundland and Jamaica. A. E. Outerbridge, Jr. An account of some of the deposits of these two colonies of Great Britain. Ills. 2000 w. Jour Fr Inst—Dec., 1909. No. 10136 D.

Ore Deposits.

Outcrop of Ore Bodies. William H. Emmons. Describes the topography of lode-deposits and what they indicate, and related matters that are of importance in the study. Ills. 3500 w. Min & Sci Pr—Dec. 4, 1909. Serial. 1st part. No. 9998.

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RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Safety.

Progressive Safety. A. H. Smith. From an address delivered before the Nat. Assn. of Ry. Commissioners, at Washington, D. C. Gives a summary of the development showing the adjustment of safety to progress. 1000 w. R R Age Gaz—Dec. 17, 1909. No. 10129.

Signaling.

Second Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission. 11600 w. Interstate Com Com—Nov. 22, 1909. No. 10466 N.

Railway Signaling. Col. Henry G. Prout, in *Harper's Weekly*. Discusses the block-signal question as related to the United States, and also the need of discipline. 1500 w. R R Age Gaz—Dec. 24, 1909. No. 10373.

Electric Interlocking. W. B. Kouwenhoven. Illustrates and describes the electro-pneumatic interlocking mechanism and its working. 2000 w. Ry & Loc Engng—Dec., 1909. No. 9826 C.

See also Train Operation, under CONDUCTING TRANSPORTATION.

Train Operation.

Train Operation in Chicago Freight Tunnels. Explains the conditions and difficulties and illustrates and describes the signaling apparatus. 2000 w. Elec Wld—Dec. 23, 1909. No. 10360.

Train Speed.

The Economic and Efficient Speed of Freight Trains. From an article by John D. Isaacs and E. E. Adams in the Bulletin of the Am. Main. of Way Assn. Develops formulæ and diagrams showing the operating efficiency of locomotives. 1600 w. Eng Rec—Dec. 11, 1909. No. 10008.

A Fast Run on the New York Branch of the Philadelphia & Reading Railway. Speed curve and details of a run from Philadelphia to New York. 800 w. Am Engr & R R Jour—Dec., 1909. No. 9908 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Defective H-6 Brake on the Road. Suggestions as to what can be done in an emergency. Ills. 2500 w. Ry & Loc Engng—Dec., 1909. No. 9825 C.

The Berne International Conference on Continuous Brakes for Goods Trains (La Conferenza internazionale di Berna sui Freni continui per Treni merci). Describes the organization and personnel of the conference and gives the test of the resolutions adopted. 5000 w. Ing Ferro—Nov. 1, 1909. No. 10247 D.

Car Doors.

Automatic Safety Latches for Car Doors (Les Loqueteaux automatiques de Sureté pour Portières de Chemins de Fer). Ch. Dantin. Describes a number of types used on European railways. Ills. 2000 w. Génie Civil—Nov. 27, 1909. No. 10232 D.

Car Ventilation.

See same title, under STREET AND ELECTRIC RAILWAYS.

Electrification.

Electrification of Chicago Railways. C. A. Seley. A detailed discussion of the subject showing that at the present time the demand for electrification is unreasonable. General discussion. 8500 w. Pro W Ry Club—Nov. 16, 1909. No. 10312 C.

Headlights.

A Comparative Test of Electric and Acetylene Headlights on Locomotives. Henry L. Gray. A report of tests made in the state of Washington. 2000 w. Eng News—Dec. 30, 1909. No. 10506.

Locomotive Feed-Water.

The Use of Feed-Water Heaters for Locomotives. Illustrates and describes particulars of systems now in use. 2500 w. Eng News—Dec. 2, 1909. No. 9850.

Locomotive Fuels.

Are the Present Day Instructions with Regard to the Eoconomical Use of Fuel in Locomotives of Such a Nature as to Bring About the Desired Results? T. E. Adams. A short paper criticizing these instructions, and opening an extended discussion. 13000 w. Pro St Louis Ry Club—Nov. 12, 1909. No. 10073.

Tests of Run-of-Mine and Briquetted Coal in a Locomotive Boiler. Walter T. Ray and Henry Kreisinger. A report of comparative steaming tests to study the performance of two types of briquets and of the coal. Ills. 8000 w. U S Geol Surv—Bul. 412. No. 10077 N.

Locomotive Power.

Locomotive Proportions and Power. G. James Wells. A discussion aiming to furnish a basis for determining the power of an engine and its ability to do its work. 3000 w. Engr, Lond—Dec. 17, 1909. Serial. 1st part. No. 10413 A.

Locomotives.

Compound Engines. R. M. Deeley. Gives facts relating to such engines as proved by tests, and a comparison with simple engines. 1800 w. Engr, Lond—Dec. 17, 1909. No. 10411 A.

Four-Cylinder Simple Engine for the Rock Island. Illustrated description of engines of the Atlantic type, with four simple cylinders arranged on the balance

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principle and using superheated steam. Designed for high-speed passenger service. 2000 w. Ry & Loc Engng—Dec., 1909. No. 9827 C.

Four-Cylinder Simple Locomotive with Superheater. Illustrated detailed description of four-cylinder engines for regular service on the C., R. I. & P. Ry., using superheated steam. 2000 w. Am Engr & R R Jour—Dec., 1909. No. 9906 C.

Record-Breaking Freight and Passenger Locomomtives for the Santa Fe. Illustrates and describes articulated and balanced compound engines with superheaters and reheaters. 3000 w. Am Engr & R R Jour—Dec., 1909. No. 9909 C.

Converted Mallet Locomotive for the Great Northern. Illustrates and describes a leading unit designed to be placed in front of an existing consolidation engine, converting it into an articulated compound of the Mallet type. 700 w. R R Age Gaz—Dec. 17, 1909. No. 10127.

Garratt Locomotive for the Tasmanian Government Railways. Plates and detailed description of two duplex locomotives of unusual interest. 2000 w. Engng—Dec. 10, 1909. No. 10192 A.

Pacific Locomotive for the Western Railway of France. Illustrated detailed description of engines showing the most advanced practice in French design, and interesting because of their resemblances to and descriptions from American practice. Plate. 4200 w. R R Age Gaz—Dec. 10, 1909. No. 10028.

Locomotive Spark-Arresters.

Spark Arresters for Locomotives. Illustrated description of an improved type designed by R. E. Preston and J. F. McIntosh. 1200 w. Prac Engr—Dec. 3, 1909. No. 10059 A.

Locomotive Speed.

Limited Speed of Passenger Locomotives. Editorial indicating some desirable features of high-speed locomotives and some means by which they may be improved. 1200 w. R R Age Gaz—Dec. 24, 1909. No. 10372.

Locomotive Valve Gears.

The Joy Valve Gear. Illustrated detailed description. 1500 w. Ry & Loc Engng—Dec., 1909. No. 9824 C.

Motor Cars.

Accumulator Railway Cars for the Prussian State Railways. C. Van Langendonck. Illustrated description of the new accumulator double cars used for large through trains and heavy branch line traffic. 600 w. R R Age Gaz—Dec. 24, 1909. No. 10400.

Application of Motor Trucks to Railroad Service. T. V. Buckwalter. From a paper read before the Engng. Club of Altoona. Classifies and discusses these trucks as applied to railroad service, and their advantages. 4000 w. Ry & Engng Rev—Dec. 25, 1909. No. 10458.

Shops.

In a Modern Locomotive Shop. Fred H. Colvin. Illustrates and describes machines, operations and devices used at the Schenectady Works of the American Locomotive Co. 900 w. Am Mach—Vol. 32. No. 52. No. 10501.

The Silvis Shops of the Chicago, Rock Island & Pacific. Angus Sinclair. Illustrated detailed description of the shops and their equipment. 3500 w. Ry & Loc Engng—Dec., 1909. No. 9823 C.

Tool Lay-Out for the Scranton Shops of the Delaware, Lacawanna & Western. Gives the schedule prepared by a committee, showing the tools required at the opening of the shops and the additions needed when brought to their full capacity. 7500 w. R R Age Gaz—Dec. 3, 1909. No. 9876.

See also Foundries, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Train Lighting.

Electric Train Lighting. R. L. Watts. Outlines the three systems in use. Ills. 900 w. Cal Jour of Tech—Dec., 1909. No. 10336.

The Train Lighting System of Brown, Boveri & Co. (Elektrische Zugsbeleuchtung der Aktiengesellschaft Brown, Boveri & Cie.). J. Zündel. Illustrated description. 2200 w. Elektrotech u Maschinenbau—Nov. 28, 1909. No. 10380 D.

PERMANENT WAY AND BUILDINGS.

Construction.

Original Cost and Cost of Reproduction of the Great Northern Railway (768 miles) in the State of Washington. Gives detailed actual cost of construction, with data not previously printed. 5000 w. Engng-Con—Dec. 8, 1909. No. 10024.

Switches.

Switch Adjustment. W. H. Arkenburgh. A discussion of switch construction and suggested improvements. 2000 w. R R Age Gaz—Dec. 10, 1909. No. 10027.

Terminals.

Plans and Ordinance for New Union Station and Terminals at Kansas City, Mo. Plans and description of extensive freight and passenger terminals and a new union passenger station to be constructed at Kansas City. Inset. 3000 w. R R Age Gaz—Nov. 19, 1909. No. 9417.

Railway Terminals and Thier Relation to City Planning. Frederick A. Delano. Read before the Am. Inst. of Archts. Discusses the conditions affecting the plan of cities, the relation of railway terminals to city development, etc. 4500 w. Eng Rec—Dec. 18, 1909. No. 10158.

Track Construction.

Kendrick Tie Finishing and Screw Spike Driving Machines. Illustrates and describes a method devised to use soft wood

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ties and overcome their objections, and the machines used by the A., T. & S. F. Ry. 1000 w. R R Age Gaz—Dec. 24, 1909. No. 10374.

Mechanical Aids to Railroad Building. Frank C. Perkins. Illustrates and describes machines used in the construction of modern railroad beds and for track grading. 1600 w. Sci Am Sup—Nov. 27, 1909. No. 9490.

Track Construction on the Belgian State Railways (La Voie courante des Chemins de Fer de l' Etat Belge). Pierre Decamps. Describes various types of construction and gives the official specifications for materials. Ills. 14000 w. Rev Gen des Chemins de Fer—Oct., 1909. No. 9516 G.

Tunnels.

Tunnel Failures and Repairs on the Eastern Railway of France. M. Siegler, in *Rev. Gen. des Chem. de Fer.* Information relating to repair and reconstruction work. 5000 w. Eng News—Dec. 23, 1909. No. 10351.

Turntables.

Examples of Practice in Turntable Construction, with some data on Costs. Extract from a Committee Report of the American Railway Bridge and Building Assn., discussing proper length, plate girder tables and cost, cast iron tables and cost, gallows frame tables and cost, foundations, power, etc. Ills. 4500 w. Engng-Con—Oct. 27, 1909. No. 9015.

TRAFFIC.

Earnings.

Comparative Effects of Business Depression on Earnings of Railways and Other Concerns. F. E. Voegelin. Gives comparative statistics of the earnings of railways and the large industries. 1200 w. R R Age Gaz—Dec. 24, 1909. No. 10401.

Live Stock.

Historical Sketch of Live Stock Transportation. Information from a report by Frank Andrews, issued by the U. S. Dept. of Agriculture. 2200 w. R R Age Gaz—Dec. 10, 1909. No. 10029.

MISCELLANY.

German East Africa.

Railways in the German Colonies (Die Eisenbahnen in den deutschen Schutzgebieten). Herr Baltzer. Describes railway developments in the German African possessions. Ills. 11000 w. Glasers Ann —Nov. 15, 1909. No. 10288 D.

Government Control.

The Protective Tariff and Railway Regulation. Samuel O. Dunn. Reprinted from *The World To-Day.* Discusses the different attitude of the government toward manufacturers and toward railways. 2800 w. R R Age Gaz—Dec. 17, 1909. No. 10128.

Legislation.

The Equipment Industries and Railroad Prosperity. W. H. Marshall. Address at dinner of the Ry. Business Assn. Remarks on railroad legislation and related subjects. 2200 w. Am Engr & R R Jour —Dec., 1909. No. 9907 C.

South America.

The Progress of Engineering in South and Central America. This first article of a series gives an illustrated description of the railway system of Venezuela. 3000 w. Engr. Lond. Nov. 26, 1909. Serial. 1st part. No. 9943 A.

United States.

Chicago and the Railroad System of the Middle West. An illustrated account of the development of the great railway systems of which Chicago is the center. 4000 w. Sci Am—Dec. 11, 1909. No. 9993.

STREET AND ELECTRIC RAILWAYS.

Berlin.

Berlin's Rapid Transit Problem (Der gegenwärtige Stand der Berliner Schnellverkehrsfragen). Describes present transport facilities and the lines along which extension is needed. Ills. Serial. 1st part 2200 w. Deutsche Bau—Nov. 6, 1909. No. 10268 B.

Boston.

Recent Extensions of the Boston Elevated System. An illustrated account of important elevated and subway extensions to the north, south and west of the city. 4500 w. Elec Ry Jour—Dec. 18, 1909. No. 10120.

Buenos Ayres.

Electric Traction Conditions in the Argentine Republic. A. C. Kelly. Map and brief account of the Buenos Ayres suburban railways. 700 w. Engng—Dec. 3, 1909. No. 10067 A.

Car Maintenance.

Hints on Inspection and Maintenance of Car Equipment. H. A. Leonhauser. Discusses details which are of importance in securing proper and economical maintenance. 6500 w. Elec Ry Jour—Dec. 4, 1909. No. 9858.

Cars.

The New A. E. G. Cars for the Blankenese-Ohlsdorf Railway (Die neuen A. E. G. Wagen für die Stadt- and Vorortbahn Blankenese-Ohlsdorf). Gustav Dietl. Describes in detail the mechanical and electrical features of the new equipment built by the All. Elek. Gesell. Ills. 4000 w. Elek Kraft u Bahnen—Nov. 4, 1909. No. 10296 D.

Car Ventilation.

Two Recent Developments in Car Ventilation. Describes a new system being tried on street cars in Chicago, and gives

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particulars of an improvement for ventilating sleeping-car berths and dining-car refrigerators. Ills. 1000 w. Eng News—Dec. 23, 1909. No. 10349.

Cost Systems.

Electric Tramway Costing and Statistics. Gives schedule forms and explanations of their use. 1000 w. Elec Rev, Lond—Dec. 10, 1909. Serial. 1st part. No. 10174 A.

Current Collectors.

Bow v. Trolley. A. Schmit. A comparison of these two types of current collectors as to cost and uses of trolley wire. Ills. 1200 w. Tram & Ry Wld—Dec. 2, 1909. No. 10102 B.

Direct Current.

A 2750-Volt Direct Current System. A. H. Barringer. Gives a brief description of the district in which the system is operating, and a review of the system. 2000 w. Can Soc of Civ Engrs—Dec. 9, 1909. No. 10084 N.

Electric Traction.

Comparative Cost of Traction Systems. O. Tissot. Abstract of a report to the Int. Cong. on the Applications of Electricity. Deals with control and sub-station distributing lines and trolley lines, both as regards first cost and operating expenses. 1000 w. Elect'n, Lond—Dec. 31, 1909. No. 10744 A.

The Future of Street Railway Service in Large Cities. Willison Fish. Explains the circumstances of present-day service, with special reference to Chicago, urging the reserving of the right of way for street car use, elimination of stopping places, etc. 1500 w. Elec Ry Jour—Jan. 1, 1910. No. 10528.

Elevated Railways.

London's First Elevated Electric Railway. W. B. Paley. Brief description of the South London railway connecting Victoria and London Bridge. 1200 w. Eng Rec—Dec. 25, 1909. No. 10436.

Experimental Line.

The Oranienburg Experimental Line of the Prussian Government Railways Illustrated description of a test road near Berlin, and some of the experiments. 1200 w. Elect Ry Jour—Dec. 25, 1909. No. 10365.

Locomotives.

Special Locomotives for Alpine Electric Railways (Ueber Spezialloкomotiven für elektrisch betriebene Alpenbahnen). W. Kummer. A comparison with the steam equipment they have displaced. 2000 w. Schweiz Bau—Nov. 20, 1909. No. 10271 B.

Monorail.

The Scherl Monorail-road of Germany. Wilhelm Kübler. Illustrated description of a successful experimental road using cars with two gyrostats. 2500 w. Am Mach—Vol. 32. No. 52. No. 10502.

Mono-Railways (Die Einschienenbahn). Eugen Eichel. Describes the Scherl and Brennan systems. Ills. 1800 w. Elek Kraft u Bahnen—Nov. 24, 1909. No. 10298 D.

Pittsburgh.

Rapid Transit for Pittsburgh. A discussion. 11000 w. Pro Engrs' Soc of W Penn—Nov., 1909. No. 10074 D.

Rack Railways.

The Montreux-Glion Electric Rack Railway (Die elektrische Zahnradbahn Montreux-Glion). George Zindel. Description of the propelling mechanism and track arrangement. Ills. 1600 w. Elek Kraft u Bahnen—Nov. 13, 1909. No. 10297 D.

Railless.

European Trackless Trolley Vehicles and Installations. Ernst Valentin. Illustrates and describes systems in use in Germany and Austria. 2000 w. Horseless Age—Dec. 1, 1909. No. 9867.

Review of 1909.

Recent Electric Railway Progress. A. H. Armstrong. Reviews the advances of the past year. 2200 w. Elec Ry Jour—Jan. 1, 1910. No. 10525.

Single Phase.

Multiple Unit Circuits for Single-Phase Trains. Ralph W. Krass. Describes an installation that has been in successful use for three years in trunk-line service. 2500 w. Elec Wld—Dec. 30, 1909. No. 10504.

Padova-Fusina Single-Phase Railway. Mario Stoppoloni. Illustrated account of this Italian line. 17000 w. Elec Wld—Dec. 9, 1909. No. 9977.

Single-Phase Traction on the Padua-Fusina Railway (I Motori monofasi e la Tramvia Padova-Fusina). Mario de Giuli. Brief description of interesting features. Ills. 2000 w. Industria—Nov. 21, 1909. No. 10243 D.

Subways.

Comparison of Operation of the New York and Paris Subway Systems. Robert H. Whitten. 5500 w. Elec Ry Jour—Dec. 11, 1909. No. 9996.

The Main Street Subway, Cambridge, Massachusetts. Plan anl proposed cross-sections, with description. 1200 w. Eng Rec—Jan. 1, 1910. No. 10517.

Switzerland.

A New Swiss Mountain Road. Illustrated description of the Martigny-Chatelard line. 2000 w. Sci Am Sup—Dec. 11, 1909. No. 9995.

Valuation.

Valuation of Public Service Corporations. W. H. Williams. Abstract of a paper presented at a joint meeting in New York. A discussion of whether a fair valuation is possible. How it should be made, its use, etc. 2500 w. Elec Ry Jour Jan. 8, 1910. No. 10655.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

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Geschwindigkeitsmesser. By Fr. Pflug. Size, 9 by 6 in.; pp., 204. Ills. Price, M. 9. Berlin: Julius Springer.

Machines-Outils. By P. Gorgeu. Size, 10 by 6½ in.; pp., 232. Ills. Price, 7 fr. 50 c. Paris: Gauthier-Villars.

Leçons sur les Alliages Métalliques. By J. Cavalier. Size, 10 by 6½ in.; pp., 466. Ills. Paris: Vuibert et Nony.

Annuaire du Bureau des Longitudes, 1910. Size, 6 by 4 in.; pp., 862. Price, 1 fr. 50 c. Paris: Gauthier-Villars.

La Materia radiante e i Raggi Magnetici. Augusto Righi. Size, 9 by 6 in.; pp., 308. Ills., 68. Bologna: Nicola Zanichelli.

Practical Irrigation. By Aug. J. Bowie. Size, 9 by 6 in.; pp., 232. Ills. Price, $3. New York: McGraw Publishing Company.

Oak Flooring. By Henry H. Gibson. Size, 9 by 6 in.; pp., 38. Ills. Price, 50 cents. Chicago, Ill.: The Hardwood Record.

Electric Lamps. By Maurice Solomon. Size, 8½ by 5½ in.; pp., 321. Ills. Price, $2. New York: D. Van Nostrand Company.

The Volcanic Origin of Coal. By Col. A. T. Fraser. Size, 8½ by 5½ in.; pp., 21. Ills. Price, 6d. London: Robert Banks & Son.

How to Build Up Furnace Efficiency. By Jos. W. Hays. Size, 6½ by 4 in.; pp., 56. Price, 50 cents. Chicago: Published by the Author.

Steam Turbines. By Hubert E. Collins. Size, 7 by 5 in.; pp., 186. Ills. Price, $1. New York and London: Hill Publishing Company.

Sewers and Drains. By Anson Marston. Size, 9½ by 6½ in.; pp., 156. Ills. Price, $1. Chicago: American School of Correspondence.

Azimuth. By George L. Hosmer. Size, 7½ by 5 in.; pp., 73. Ills. Price, $1. New York: John Wiley & Sons; London: Chapman & Hall.

Internal Combustion Engines. By Wm. M. Hogle. Size, 9 by 6 in.; pp., 256. Ills. Price, $3. New York: McGraw Publishing Company.

Steam-Electric Power Plants. By Frank Koester. Size, 10¼ by 7½ in.; pp., 455. Ills. Price, $5. New York: D. Van Nostrand Company.

Lessons in Telegraphy. By Charles Henry Sewall. Size, 7¼ by 5 in.; pp., 88. Ills. Price, $1. New York: D. Van Nostrand Company.

The New Building Estimator. By William Arthur. Size, 6½ by 4½ in.; pp., 437. Price, $2.50. New York: David Williams Company.

Boiler Accessories. By Walter S. Leland. Size, 9½ by 6½ in.; pp., 123. Ills. Price, $1. Chicago: American School of Correspondence.

The Evolution of Worlds. By Percival Lowell. Size, 9 by 6 in.; pp., xiii, 262. Ills. Price, $2.50. New York: The Macmillan Company.

Sewage Purification and Disposal. By J. J. Cosgrove. Size, 8 by 5½ in.; pp., 222. Ills. Price, $3. Pittsburg, Pa.: Standard Sanitary Mfg. Co.

The Principles of Mechanics. By Henry Crew. Size, 8 by 5 in.; pp., x, 295. Ills. Price, $1.50. New York and London: Longmans, Green & Co.

A Brief History of Cements. By I. C. Johnson. Size, 9 by 6 in.; pp., 27. Ills. Price, 50 cents. Kansas City, Mo.: The Cement Record Co.

The Design and Construction of Induction Coils. By A. Frederick Collins. Size, 9 by 6 in.; pp., 272. Ills. Price, $3. New York: Munn & Co.

First Annual Report of the Board of Supervision Engineers, Chicago Traction. Size, 9 by 6 in.; pp., 462. Ills. Chicago: Published by the Board.

Hydro-Electric Practice. By H. von Schon. Size, 10 by 7½ in.; pp., xv, 382. Ills. Price, $6. Philadelphia and London: J. B. Lippincott Company.

Proceedings of the First Meeting of the Illinois Water Supply Association. Size, 9 by 6 in.; pp., 188. Ills. Urbana, Ill.: Published by the Society.

Alternating Current Motors. B. A. S. McAllister. Third Edition. Size, 9 by 6 in.; pp., xii, 322. Ills. New York: McGraw-Hill Book Company.

Gold and Silver. By Walter R. Crane. Size, 9 by 6 in.; pp., 727. Ills. Price, $5, 21/. New York: John Wiley & Sons; London: Chapman & Hall.

High-Tension Underground Electric Cables. By Henry Floy. Size, 7½ by 5

in.; pp., 135. Ills. Price, $2. New York: Electrical Publishing Company.

General Lectures on Electrical Engineering. By Charles Proteus Steinmetz. Size, 9 by 6 in.; pp., 284. Ills. Price, $2. Schenectady, N. Y.: Robson & Adee.

Hydroelectric Developments and Engineering. By Frank Koester. Size, 10¼ by 7½ in.; pp., 454. Ills. Price, $5. New York: D. Van Nostrand Company.

Bridge Engineering and Roof Trusses. By Frank O. Dufour. Size, 9½ by 6½ in.; pp., 350. Ills. Price, $3. Chicago, Ill.: American School of Correspondence.

Energy: Work, Heat and Transformations. By Sidney A. Reeve. Size, 9 by 6 in.; pp., 238. Ills. Price, $2. New York: McGraw-Hill Book Company.

Radiation, Light and Illumination. By Charles Proteus Steinmetz. Size, 9 by 6 in.; pp., xii, 305. Ills. Price, $3. New York: McGraw-Hill Book Company.

Curves for Calculating Beams, Channels and Reactions. By Sidney Diamant. Size, 7 by 10 in.; pp., 64. Ills. Price, $2. New York: McGraw Publishing Company.

Metallographie. By Dr. W. Guertler. Volume I: Die Konstitution, Part 1. Size, 10 by 7 in.; pp., 80. Ills. Price, 4.20 M. Berlin: Verlag von Gebrüder Borntrager.

Paints for Steel Structures. By Houston Lowe. Fifth Edition. Size, 7¼ by 5 in.; pp., 115. Price, $1, 4/6. New York: John Wiley & Sons; London: Chapman & Hall.

Railroad Structures and Estimates. By J. W. Orrock. Size, 9 by 6 in.; pp., 270. Ills., 93. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Gear-Cutting Machinery. By Ralph E. Flanders. Size, 8 by 5½ in.; pp., 319. Ills. 219. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Descriptive Geometry. By Gardner C. Anthony and George F. Ashley. Size, 6 by 7½ in.; pp., x, 164. Ills. 195. Price, $2. New York and London: D. C. Heath & Co.

Proceedings of the Seventeenth Annual Convention of the Traveling Engineers' Association. Size, 8½ by 6 in.; pp., 373. Ills. Buffalo, N. Y.: Published by the Society.

Hydraulics of Rivers, Weirs and Sluices. By David A. Molitor. Size, 9 by 6 in.; pp., xii, 135. Ills., 72. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

How to Understand Electrical Work. By William H. Onken and Joseph B. Baker. Size, 8 by 5½ in.; pp., 359. Ills. Price, $1.75. New York and London: Harper & Brothers.

Methods for Earthwork Computations. By C. W. Crockett. Size, 9 by 6 in.; pp., x, 114. Ills. 90. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

Light and Sound. By Wm. S. Franklin and Barry MacNutt. Size, 8½ by 5½ in.; pp., 344. Ills. Price, $1.60. New York: The Macmillan Company; London: Macmillan & Co.

Theoretical Elements of Electrical Engineering. By Charles Proteus Steinmetz. Third Edition. Size, 9 by 6 in.; pp., 455. Ills. Price, $4. New York: McGraw-Hill Book Company.

Principles of Direct Current Electrical Engineering. By James R. Barr. Size, 9 by 6 in.; pp., 551. Ills. Price, $3.25. New York: The Macmillan Company; London: Whittaker & Co.

Practical Reinforced-Concrete Standards for the Design of Reinforced-Concrete Buildings. By H. B. Andrews. Size, 11¼ by 8 in.; pp., 40. Ills. Boston: Simpson Bros.' Corporation.

Grounded Electric Transmission and Electrolytic Corrosion. By J. Stanley Richmond. Size, 9 by 6 in.; pp., 69. Ills. Price, 50 cents. Toronto, Canada: The Canadian Engineer.

Paving Brick and Paving Brick Clays of Illinois. By C. W. Rolfe, R. C. Purdy, A. N. Talbot and I. O. Baker. Size, 9 by 6 in.; pp., 316. Ills. Urbana, Ill.: Illinois State Geological Survey.

The Mineral Content of Illinois Waters. By Edward Bartow, J. A. Udden, S. W. Parr and George T. Palmer. Size, 9 by 6 in.; pp., 192. Ills. Urbana, Ill.: Illinois State Geological Survey.

The Modern Gas Engine and the Gas Producer. By A. M. Levin. Size, 9 by 6 in.; pp., xviii, 485. Ills., 181. Price, $4, 17/. New York: John Wiley & Sons; London: Chapman & Hall.

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Building Construction and Superintendence. By F. E. Kidder. Part 1, Masons' Work. Ninth Edition. Size, 9½ by 6½ in.; pp., xix, 965. Ills., 628. Price, $6. New York: William T. Comstock.

Simplified Methods of Calculating Reinforced-Concrete Beams. By W. Noble Twelvetrees. Size, 7 by 5 in.; pp., 20. Ills. Price, 20 cents, 6d. New York: The Macmillan Company; London: Whittaker & Co.

Annual Report of the Director of the Department of Public Works and of the Chief of the Bureau of Surveys, Philadelphia, 1908. Size, 9 by 6 in.; pp., 210. Ills. Philadelphia: Published by the Department.